Biological Evaluation of Aquatic Life Criteria – Cyanide

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PREFACE

This biological evaluation was conducted based on the scientific rationale and step-by-step procedures in the *Draft Methodology for Conducting Biological Evaluations of Aquatic Life Criteria–Methods Manual* (*BE Methods Manual*) and on widely accepted ecological risk assessment practices. For each chemical evaluated as part of the National Endangered Species Act Consultations on EPA's section 304(a) aquatic life criteria, a biological evaluation, such as this one, will be prepared that includes the presentation and analysis of the toxicity data, an analysis of potential exposure and a risk characterization to make an effects determination for each listed and proposed species for that chemical. The description of the methodologies and other background material relevant to the biological evaluations are consolidated into the single *BE Methods Manual*. Since the same methodologies are employed among the chemicals considered in the national consultations, these methodology descriptions and background materials are not included in any of the biological evaluations.

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1.0 INTRODUCTION

Under this national consultation biological evaluation for cyanide, EPA is determining whether concentrations of cyanide in waterbodies resulting from EPA approval of Clean Water Act section 304(a) cyanide aquatic life criteria are likely to result in adverse effects to Federally-listed species or their designated critical habitat. In making this assessment it is necessary to consider the concentrations of cyanide that are toxic to Federally-listed species and likely concentrations of exposure in those waterbodies. Given this, commonly practiced ecological risk assessment principles are used in this biological evaluation to complement the procedures identified in the *Draft Methodology for Conducting Biological Evaluations of Aquatic Life Criteria–Methods Manual* (*BE Methods Manual*, U.S. EPA 2005 (*Draft*)).

A standard risk assessment paradigm utilizes classic problem formulation and risk characterization, consisting of the following steps: 1) hazard identification and hazard characterization, 2) exposure assessment, and 3) risk characterization. The risk assessment process determines not only the magnitude of potential hazards were they to occur, but also very importantly, whether identified hazards are likely to occur. Standard risk assessment should include professional judgments about risks and their potential effects, and provide a means of integrating such judgments for characterizing the level of risk. As such, risk assessors may find it useful to consider a range of values (distribution), as well as specific values (point estimates). Risk assessments often include screening steps to rule out hazards with minimal or no risk, and for remaining hazards, the available information is reviewed in detail to characterize the level of risk and evaluate whether the level of risk is acceptable. Ultimately, risk assessment involves the evaluation of risk to determine priorities and to enable identification of appropriate risk management measures.

As applied to ecological toxicity, standard risk assessment identifies the chemicals of concern; the frequency, concentration, and duration of these chemicals; their toxicity to plants and animals; how these organisms can be exposed to the chemicals; and at what concentrations and for how long these organisms are actually exposed. An ecological risk assessment process should be able to identify and characterize the risks resulting from a specified occurrence of a chemical, taking into account the possible harmful effects on individual organisms and populations of using the chemical in the amount and manner proposed and all the possible significant routes of exposure.

In conducting this biological evaluation on cyanide (and for the chemicals under the national consultations), EPA utilizes a standard risk assessment paradigm, employing the following steps in assessing risk to aquatic life from exposure to cyanide: 1) a toxicity assessment, which identifies and characterizes the direct and indirect effects potentially encountered by aquatic life from exposure to cyanide, 2) an exposure assessment, which evaluates all potentially significant sources of cyanide exposure to aquatic life, and 3) a risk characterization. The direct effects include toxicity to the Federally-listed species from all significant exposure routes. The indirect effects include loss of food items due to toxicity to the food items and toxic effects to host species, such as host species for early life stages of freshwater mussels. The risk assessment paradigm is applied to the assessment of effects to Federally-listed species as well as to the assessment of any designated critical habitat. This standard risk assessment paradigm, employed in the cyanide biological evaluation, is illustrated in the flow chart in Figure 1, below.

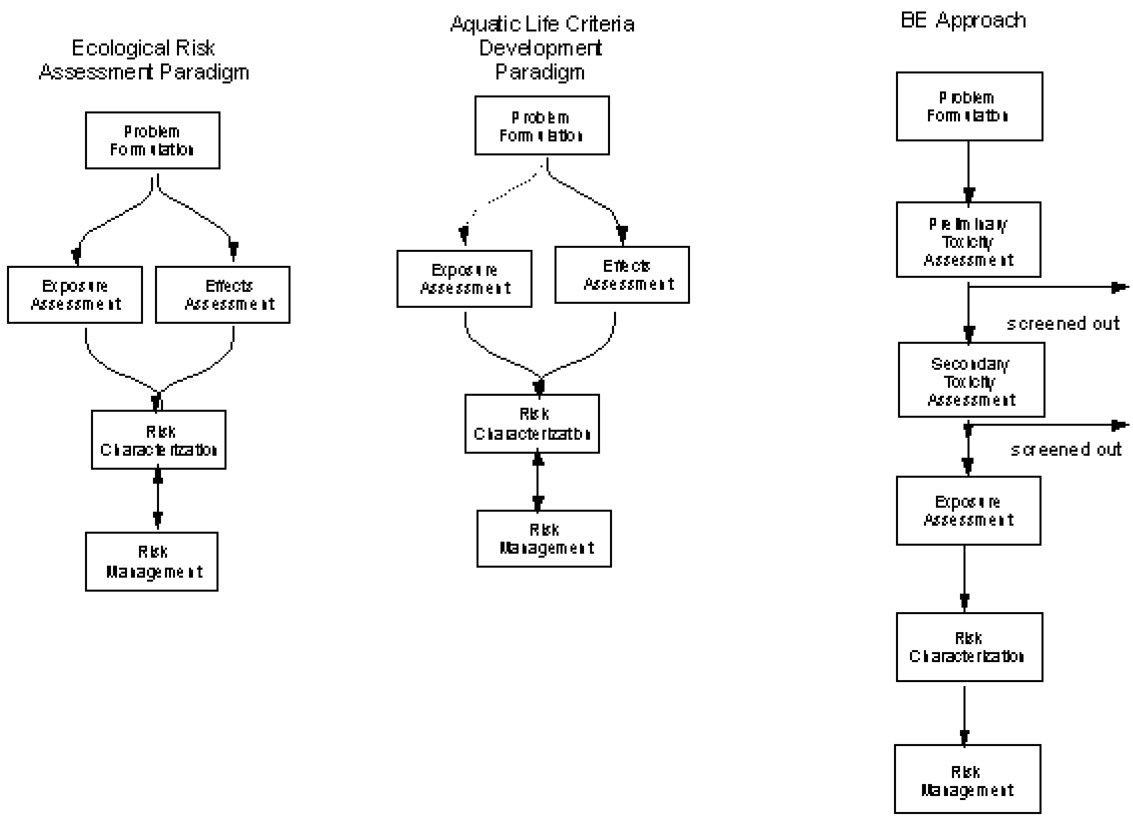

Figure 1: Risk assessment paradigm employed in the cyanide biological evaluation (BE).

EPA conducted this risk assessment as a series of conservative screens, whereby conservative estimates of toxicity and exposure where used to successively rule out species that would likely be adversely affected by cyanide. The toxicity assessment was conducted in two stages: 1) a preliminary toxicity assessment and 2) and a secondary toxicity assessment. In the preliminary toxicity assessment, conservative toxicity values were estimated for each Federally-listed species. These conservative toxicity estimates were then compared to a conservative exposure assumption that the species were continually exposed to criteria concentrations at all times and in all places. Where the conservative toxicity estimate was greater than the criteria, it was determined that risk to that species was acceptable and the species was "screened out" from the need for further assessment. EPA is confident in making a "not likely to adversely affect" determination for these species after the preliminary toxicity assessment due to the amount of conservativism in this first screen. Species not screened out in the preliminary toxicity assessment underwent a secondary toxicity assessment. In the secondary toxicity assessment, EPA further evaluated the conservative toxicity values estimated for the listed species from the preliminary toxicity assessment to better determine whether the species is likely to be adversely affected by EPA's recommended section 304(a) criteria for cyanide. Under the secondary toxicity assessment, toxicity was evaluated as specific values or as a range of values (distribution) and also compared to known toxicity data for species which were more closely related than the species used in the model to estimate toxicity. These more detailed assessments of toxicity were similarly compared to the conservative exposure assumption of continual exposure at criteria concentrations. Thus, the two toxicity assessment steps of this biological evaluation consist of a highly conservative screening, premised on the presumption that cyanide will occur in waterbodies at full criteria concentration, frequency, and duration, thereby exposing all species present to maximal, constant levels of the pollutant. To implement this screen, all available, relevant toxicity data and information on Federally-listed species or surrogates are objectively reviewed.

An assessment of real-world toxicity scenarios was then conducted to determine whether any species not screened out based on toxicity would likely encounter cyanide concentrations that would result in an adverse effect. The exposure assessment step of the risk assessment paradigm is necessary as it would be unrealistic to assume that ambient water concentrations are continually at criteria levels. Beside the magnitude component of all EPA recommended section 304(a) criteria for toxic chemicals, there are duration and frequency components. That is, the frequency and duration components typically result in ambient concentrations that are below criteria levels most of the time. Without all exposure factors being properly considered through an exposure assessment, a screening level toxicity assessment does not automatically equate to a toxic effect determination in a waterbody.

Thus, the basic task in all elements of this biological evaluation is to apply, in complement to the *BE Methods Manual*, standard risk assessment principles to the existing toxicological information to classify the aquatic life criterion for a specified chemical as "likely to adversely affect" or "not likely to adversely affect" for each listed species. The management context of this exercise is that species classified as "not likely to adversely affect" are considered to involve low risk under all circumstances, and do not require any further attention. Species that are not screened out as "not likely to adversely affect" require additional consideration and analysis, including an assessment of real-world exposure scenarios, to determine under what circumstances risks are unacceptable.

Additional background on the biological evaluations for cyanide and other aquatic life criteria chemicals is found in the “Background” section (Section 1) of the *BE Methods Manual*.

2.0 PROBLEM FORMULATION: SCOPE OF FEDERAL ACTION

2.1 Definition of Federal Action

Under section 304(a) of the CWA, EPA from time to time publishes water quality criteria that serve as scientific guidance to be used by States or Tribes in establishing and revising water quality standards. These criteria are not mandatory, but are recommended criteria levels that States or Tribes may adopt as part of their legally enforceable water quality standards. State or Tribal water quality standards serve as the basis for water quality based limits in NPDES (National Pollutant Discharge Elimination System) permits under CWA section 402. The Memorandum of Agreement between EPA, FWS, and NMFS (MOA, January 19, 2001) establishes a framework for coordinating actions by EPA and the Services for activities under CWA section 402, which include EPA review of permits issued by States or Tribes with approved permitting programs, and EPA issuance of permits.

EPA and the Services have gained considerable experience in evaluating the potential effects on listed species of pollutants on a State-by-State basis. For example, the Services have issued biological opinions as a result of section 7 consultations on aquatic life criteria approved by EPA in water quality standards adopted by the States of New Jersey, Alabama, and Arizona, and promulgated by EPA for the Great Lakes Basin. EPA also conducted consultation with the Services regarding aquatic life criteria promulgated by EPA for toxic pollutants for certain waters in California. In addition to these comprehensive formal consultations, EPA and the Services have also conducted informal consultations on State water quality standards approval actions which have covered water quality criteria contained in the standards. Although EPA and the Services have been able to complete these State-by-State consultations, EPA and the Services recognize that conducting consultations on a national basis is a more efficient approach to evaluating the effects of water pollution on listed species. National section 304(a) consultations will ensure a consistent approach to evaluating the effects of pollutants on species and identifying measures that may be needed to better protect them. National consultations will also ensure better consideration of effects on species whose ranges cross State boundaries.

As indicated in the MOA, the national consultations provide section 7 coverage for any water quality criteria included in State or Tribal water quality standards approved, or Federal water quality standards promulgated, by EPA that are identical to or more stringent than the recommended section 304(a) criteria. The MOA also indicates that, under the national consultations, separate consultation on such criteria on a State-by-State basis will not be necessary. Therefore, the Federal action addressed by the national consultation on the aquatic life cyanide criteria is the approval of State or Tribal water quality standards, or Federal water quality standards promulgated by EPA of aquatic life criteria that are identical to or more stringent than the section 304(a) cyanide aquatic life criteria. The section 304(a) cyanide criteria were derived by assessing the toxicity of cyanide to aquatic organisms based on direct exposure to the water column. Accordingly, the scope of this Federal action is the protection of aquatic organisms from contact with and ingestion of cyanide in the ambient water.

2.1.1 Established Freshwater and Saltwater Criteria for Cyanide

The section 304(a) aquatic life criteria serve as recommendations to States and Tribes in defining water column concentrations that should protect against adverse ecological effects to aquatic life as a result from exposure to a single pollutant found in the water column from direct contact or ingestion. Aquatic life criteria address the Clean Water Act 101(a)(2) & (3) goals and policy of attaining "water quality which provides for the protection and propagation of fish, shellfish, and wildlife," and are the basis for deriving permit limits, which prevent the discharge of toxic pollutants in toxic amounts.

EPA's numeric aquatic life criteria recommendations are calculated to protect aquatic organisms from unacceptable toxicity during acute (short) and chronic (long) exposures in the water column of a waterbody. EPA's acute criterion recommendation is called the Criterion Maximum Concentration (CMC). The CMC is derived from a set of LC50 values for a variety of aquatic species (i.e., LC50 is the concentrations of a chemical which causes 50% mortality, immobilization, or loss of equilibrium in 48- to 96-hour laboratory tests). To provide aquatic organisms a level of protection much better than 50% mortality, the CMC is set to one-half of the fifth percentile of the Genus Mean Acute Values (GMAVs) for the various species tested. To make exceeding this level of toxicity a relatively rare event, EPA's Technical Support Document (U.S. EPA 1991) recommends that the one-hour average exposure concentrations should not exceed the CMC more than once every three years on the average.

EPA's chronic criterion recommendation is called the Criterion Continuous Concentration (CCC). The CCC is derived from a set of 'Chronic Values', which are the geometric mean of the highest no observed effect concentrations (NOECs) and lowest observed effect concentrations (LOECs) for survival, growth, or reproduction in tests which range from seven days to several months or more). Either by direct calculation or by the use of acute-to-chronic ratios (ACRs), the CCC is set to an estimated fifth percentile of Chronic Values. To make exceeding the level of toxicity associated with the CCC a relatively rare event, EPA's Technical Support Document (U.S. EPA 1991) recommends that four-day average exposure concentrations should not exceed the CCC more frequently than once every three years on the average. The tests used to develop the CMC and the CCC generally involve only the use of chemicals dissolved in water, so that the route of exposure is via contact, aspiration, and ingestion of water, with exposure to chemicals on solids and food considered only to the limited extent that the chemical in water partitions onto them.

The section 304(a) cyanide aquatic life criteria are expressed in the 1984 cyanide criteria document (U.S. EPA 1984) as:

Freshwater CMC (as free cyanide) = 22.36 µg/L
Freshwater CCC (as free cyanide) = 5.221 µg/L
Saltwater CMC (as free cyanide) = 1.015 µg/L
Saltwater CCC (as free cyanide) = 1.015 µg/L

Cyanide occurs in water as hydrocyanic acid (HCN), the cyanide ion (CN^-), simple cyanides, metallocyanide complexes, and as simple chain and complex ring organic compounds (Callahan, *et al.* 1979). "Free cyanide" is defined as the sum of the cyanide present as HCN and as CN^-, and the relative concentrations of these two forms depend mainly on pH and temperature. When pH is below 8 and temperature is below 25 °C, at least 94 percent of the free cyanide exists as HCN. When pH or temperature or both are higher, a greater percentage of free cyanide exists as CN^-. For example, when pH is 9 and temperature is 30 °C, about 55 percent of the free cyanide exists as HCN. The CWA section 304(a) aquatic life criteria for cyanide are expressed as free cyanide, CN, because free cyanide is a more reliable index of toxicity to aquatic life than total cyanide. Total cyanide can include nitriles (organic cyanides) and relatively stable metallocyanide complexes.

Although simple cyanides such as sodium cyanide and potassium cyanide readily dissociate and hydrolyze to form CN^- and HCN, the metallocyanide complex anions have a wide range of stabilities. Zinc and cadmium cyanide complexes dissociate rapidly and nearly completely in dilute solutions, whereas the stability of the copper and nickel metallocyanide anions are pH-dependent. Cyanide complexes of iron dissociate very little, but they are subject to photolysis by natural light. Release of cyanide ion by photodecomposition might be important in relatively clear receiving waters.

The apparent toxicity to aquatic organisms of most simple cyanides and metallocyanide complexes is due mainly to the presence of HCN derived from dissociation, photodecomposition, and hydrolysis (Doudoroff, *et al.* 1966; Smith, *et al.* 1979), although CN^- is apparently also toxic (Broderius, *et al.* 1977). Most metallocyanide complexes are not very toxic. The available literature on the toxicity of cyanides and related compounds to fish was critically reviewed by Doudoroff (1976, 1980). Additional reviews on the environmental effects of cyanides have been prepared by Eisler, *et al.* (1999), Hill and Henry (1996), Leduc (1984), Leduc, *et al.* (1982), and Towill, *et al.* (1978).

The data used in this analysis document incorporated most of the data reported in the 1984 cyanide criteria document, with only a few exceptions, as well as additional data retrieved as a result of literature searches and data calls to the Services and EPA regional and field offices. All cyanide concentrations reported herein are in terms of free cyanide expressed as CN. Thus, data reported in the original literature in terms of free cyanide expressed as CN did not have to be adjusted. However, when free cyanide was expressed as HCN, KCN, NaCN, etc., the results were adjusted using the molecular weights of the compound and [CN]. When data were reported in the original literature in terms of [HCN], rather than in terms of free cyanide, the data were converted from molecular HCN to free cyanide as CN as follows:

$$(\mu g \text{ of free cyanide as CN/L}) = (\mu g \text{ of HCN/L}) (1 + 10^{pH - pK_{HCN}}) \times \frac{\text{mol. wt. CN}}{\text{mol. wt. HCN}}$$

$$\text{where } pK_{HCN} = 1{,}3440 + \frac{2347.2}{T + 273.16} \qquad \text{(Izatt, } et\ al. \text{ 1962)}$$

and T = degrees Celsius.

2.2 Definition of Action Area

The action area consists of all “waters of the United States,” including “territorial seas,” which extend seaward a distance of three miles from the coast (CWA section 502), where Federally-listed endangered, threatened, and proposed species reside. This action area includes such waters within and surrounding Tribes, the 50 States, and all U.S. territories. “Waters of the United States” is defined under 40 CFR Section 122.2, as provided in Appendix A of the *BE Methods Manual,* and reiterated here.

(1) All waters that are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters that are subject to the ebb and flow of the tide;

(2) All interstate waters, including interstate wetlands;

(3) All other waters, such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation, or destruction of which would or could affect interstate or foreign commerce, including any such waters:

  (i) which are or could be used by interstate or foreign travelers for recreational or other purposes; or
  (ii) from which fish or shellfish could be taken and sold in interstate or foreign commerce; or
  (iii) which are used or could be used for industrial purposes by industries in interstate commerce;

(4) All impoundments of waters otherwise defined as waters of the United States under this

definition;

(5) Tributaries of waters identified in paragraphs 1-4;

(6) The territorial sea; and

(7) Wetlands adjacent to waters (other than waters that are themselves wetlands) identified above in paragraphs 1-6.

Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of the Clean Water Act (other than cooling ponds as defined in 40 CFR 423.11(m) that also meet criteria in this definition) are not waters of the United States.

2.3 Description of Listed and Proposed Species and Critical Habitats

Federally-listed aquatic or aquatic-dependent species that have more than limited exposure to "waters of the United States" are assessed in this biological evaluation. From an initial list of 555 Federally-listed species, EPA has identified 446 aquatic and aquatic-dependent animal and plant species that have more than limited exposure to "waters of the U.S." and which may be affected by the section 304(a) aquatic life criteria for cyanide. This list includes 25 mammals, 31 birds, 19 reptiles, 12 amphibians, 117 fish, 21 crustaceans, 21 gastropods, 69 bivalves, 11 insects, and 120 aquatic or wetland plants. The 446 aquatic and aquatic-dependent animal and plant species identified constitute the full range of species that may be affected by the national aquatic life criteria. For such species, EPA will also determine whether the section 304(a) criteria are likely to adversely affect any of their critical habitat. A complete list of the Federally-listed aquatic and aquatic-dependent species (including proposed species) is in Appendix B of the *BE Methods Manual*, Parts 1 and 2. A description of the designated critical habitat relevant to this biological evaluation is provided in Appendix B of the *BE Methods Manual*, Part 4.

Part 3 of Appendix B of the *BE Methods Manual* lists species from Parts 1 and 2 of Appendix B for which all important life stages do not have more than limited exposure to Waters of the United States. EPA considered migration patterns in determining whether a species has more than limited exposure to Waters of the Unites States. The agencies have agreed that those species that have only a limited exposure to water (i.e., terrestrial species) will not be affected by the national aquatic life criteria and that it is appropriate for EPA to make a 'no effect' finding on such species.

2.4 Consideration of Life History Information

To ensure that all important exposure routes are assessed for each of the listed species, all important life stages (i.e., for the purposes of this evaluation) of each of the listed species are identified in Appendix C of the *BE Methods Manual*. The life stage information in Appendix C of the *BE Methods Manual* includes each important life stage, where the life stages occur in the environment, by which routes they may be exposed at various locations in the environment, and their diet.

3.0 OVERVIEW OF CLEAN WATER ACT WATER QUALITY PROGRAMS

A national objective to “restore and maintain the chemical, physical, and biological integrity” of U.S. waters was mandated by Congress in the 1972 Amendments to the Federal Water Pollution Control Act, otherwise known as the Clean Water Act (CWA). National numeric water quality criteria developed based on acute and chronic laboratory toxicity tests have been used to help achieve this objective. Water quality criteria adopted by a State or Tribe, along with the designated use of a waterbody (such as “protection and propagation of fish, shellfish, and wildlife”), and an antidegradation policy to maintain existing uses and the level of water quality necessary to protect those uses, form the basic components of State/Tribal water quality standards programs, which are the water quality standards regulations promulgated to achieve the objectives of the CWA.

Water quality standards serve two functions: they set water quality goals for a waterbody, and they serve as the regulatory basis for controls in addition to the technology-based standards of treatment. Technology-based effluent (or discharge) limitations reflect the best technology economically achievable for industrial discharges to surface waters, and constitute an important step toward achieving the congress-mandated goal and policies of the CWA, which include the eventual elimination of discharge of pollutants into navigable waters or “zero pollutant discharge,” and prohibition of discharges of toxic pollutants in toxic amounts.

One of the key concepts of the CWA is that treatment-based standards will be established at the Federal level for discharges from municipal wastewater treatment plants and various industrial categories. In addition, standards for the industrial categories are further divided into two major subdivisions -- direct discharges into waters of the U.S. and indirect discharges into municipal sewerage systems. These are promulgated by EPA and are often collectively termed "Categorical Standards.” If an industry does not fall under any of the Federal categories, then the entity responsible for regulation of point sources of pollutants in a given State must determine treatment-based requirements on a case-by-case basis, using "best professional judgment" (BPJ). The bases for the Federal standards, as well as BPJ, are set forth in section 303 of the CWA and are commonly referred to as "secondary treatment" for municipal discharges, and "best conventional treatment" and "best available treatment" for industrial discharges.

Limitations based on the Categorical Standards must be incorporated into the control document (usually the NPDES permit) for every point source discharge of wastewater -- <u>except</u> where more stringent limits must be included in order to comply with the water quality standards. In actual practice, many NPDES permit limits are based on treatment technology, and many are based on water quality standards. Those permits which have limits based on treatment technology are often more stringent than needed to protect aquatic species.

The section 304(a) water quality criteria, as well as site-specific requirements and designated beneficial uses of a particular waterbody are used by most States and Tribes to manage contaminants in surface waters to fully protect aquatic life. When a State or Tribe adopts water quality criteria into their standards, the criteria can be numerical values or narrative statements (i.e., no discharge of toxics in toxic amounts) and can be combined with other protective tools such as biological criteria, whole effluent criteria and nutrient criteria.

It is important to appreciate that the discharge of cyanide, or any other pollutant, that results in ambient concentrations of that pollutant in a waterbody is a process that is ongoing because of the historic use of waterbodies for the discharge of waste materials by industry, municipalities and other sources. In many cases, these discharges have been occurring in different, and potentially uncontrolled amounts, around the country. The intent of water quality criteria is to define a safe and healthful level in waterbodies for a pollutant, which a regulatory authority can use to guide the control, reduction and eventual elimination of that pollutant.

Another important distinction is that water quality criteria themselves do not reflect ambient concentrations of a pollutant, nor do they necessarily define an allowable level up to which a pollutant may accumulate in a waterbody. Rather they define safe starting points from which a pollutant discharged into a waterbody can be managed. Most States manage pollutant discharges to levels below criteria concentrations with the intent of meeting the goal of the CWA. This is the essence of "restoration" of waterbodies and the eventual achievement of the objective of "zero discharge." Some States or Tribes even adopt water quality criteria on a protective basis. In other words, rather than wait for a discharge of a particular pollutant to occur, and then adopt a criterion to manage it, States adopt EPA's recommended section 304(a) criteria so they have a regulatory tool to prevent the excessive discharge of that pollutant, should such occur from an existing or new industry. Therefore, in States taking this preventative approach, a criterion value and the concentration of the pollutant in the States' waterbodies, may have little relation.

It is also important to appreciate that water quality criteria themselves do not have a toxic effect on anything, *per se.* When adopted into State or Tribal water quality standards, these are numbers in regulatory or legal documents that by themselves have no direct effect on listed species, as would a construction project or other similar disturbance of a species or the habitat of a species. Rather it is the discharge of a pollutant that has the effect and it is the water quality criteria that States and Tribes adopt that is intended to minimize that effect or eliminate it altogether. Without water quality criteria, there would be no limits to the discharge of a pollutant with the exception of the use of the technology-based approach to water pollution control, as described above.

Therefore, water quality criteria by themselves, do not define the exposure levels of listed species to pollutants in waterbodies, nor do they generate or lead to the exposure of endangered and threaten species to harmful concentrations of pollutants. And, given the protective process by which water quality criteria are implemented, they are intended to provide highly protective levels for pollutants in waterbodies which will help lead to the further reduction of discharges to the point of eventual elimination.

The protective process in which water quality criteria are developed and implemented, is described below. This is a critical step that must be factored when attempting to determine if pollutants at water quality criteria levels are protective of listed species.

3.1 Conservative Assumptions Designed into the Preliminary Toxicity Assessment Procedure

As described in the draft *BE Methods Manual*, the risk paradigm used for conducting a toxicity screening assessment of a pollutant in a waterbody at section 304(a) criteria levels on Federally-listed species is based on the simple screening risk ratio:

$$R = C_A/EC_A$$

Where C_A is the *screening level assessment exposure concentration* based on the maximum exposure concentrations allowed by the criteria, and EC_A is the *assessment effects concentration* that represents a maximum level of effect considered acceptable for any particular organism. This simple comparison of C_A and EC_A is also used to classify whether pollutants in a waterbody at the aquatic life criteria level for cyanide as "likely to adversely affect" or "not likely to adversely affect" for a specified listed species. For this latter comparison, C_A is effectively the "Criterion Concentration," and synonymous with the assessment exposure concentration. If $C_A<EC_A$, the criterion concentration is expected to be less than the effects concentration, and a conservative determination of *not likely to adversely affect* would be made. In contrast, if $C_A>EC_A$, the criterion concentration is expected to be above the effects concentration, and a screening determination of *a possible effect* would be made and more investigation would be triggered.

Real-World Exposures:

The risk paradigm, while elegant in its simplicity, does not reflect environmentally realistic exposure scenarios. Using this paradigm, the presumption is that a listed species would be exposed at the criteria concentrations (CMC and CCC) on a continuous basis no matter where in the waterbody the species might occur and at the proper duration and frequency to induce toxicity, which would require the concentration of cyanide in any given waterbody to be at the full criteria concentration continuously. In field situations where cyanide is likely to be discharged, variations in the flows of effluent discharges and upstream receiving waters, as well as variations in the concentrations of cyanide in the effluent discharges and upstream receiving waters, combine to virtually eliminate the likelihood of achieving constant criteria-level exposure concentrations in ambient waters. Thus, C_A, as it pertains to the effects assessment for section 304(a) criteria for cyanide, is in practice far lower than the current CCC, which is an important consideration in making effects determinations.

Real-World Criteria Applications:

A number of protective assumptions are employed in applying water quality criteria to dischargers using nationally recommended section 304(a) criteria for cyanide. The following information was assembled to illustrate how these assumptions combine to make the risk paradigm adequately protective in worst-case scenarios, and highly protective in all other scenarios.

Water quality-based effluent limits for toxics like cyanide are implemented under a State's water quality standards program. These limits are based in part on the State's adopted water quality criteria, and also on a set of duration and frequency of exposure conditions to account for the fact that aquatic organisms will only be affected given adverse duration, magnitude and frequency conditions.

3.2 Protective Assumptions Contained in Numerical Water Quality Criteria and Standards that Pertain to Cyanide

A number of standardized requirements and assumptions are used in developing water quality criteria for State water quality standards programs so that a protective set of standards are derived. These requirements and assumptions are developed by EPA using approaches designed to provide adequate protection so as to assure healthy populations of all types of aquatic organisms. Consequently, water quality standards allow the numerical water quality criteria, i.e., the CMC or CCC for toxics (including cyanide), to be reached or exceeded very infrequently if at all.

Criteria Development:

Although individual States and Tribes have varied approaches to developing water quality criteria and standards for priority pollutants, most use national recommended section 304(a) criteria which are based on the following mechanisms, or similar ones, to adequately protect aquatic life:

1. *Use of Tests on Species in Laboratory Exposures*. In the process of developing ambient water quality criteria, the acute and chronic toxicity of individual chemicals must be determined for several types of aquatic species. Typical types of test organisms include multiple species of fish, crustaceans, insects and other invertebrates. The tests are conducted using standardized

procedures with the goal of achieving constant exposure concentrations, thereby simulating worst case field conditions. The tests are also conducted with a dilution water low in particulate and organic matter to ensure that the form of the chemical in exposure water remains largely dissolved. With few exceptions, dissolved chemical concentrations are the more “biologically available” forms of the chemical and result in lower toxic thresholds. This approach provides adequate protection for species in low organic/particulate waters, and additional protection in all other waters.

2. *Use of the Most Sensitive Portion of the Test Organisms’ Life Cycle.* In performing the toxicity testing to develop ambient water quality criteria, various portions of the life cycle of the species types are considered. For example, fish larvae, juvenile and adult stages are recommended for acute toxicity tests, and the most sensitive life stages are required for chronic toxicity tests. Thus, for chronic tests in particular, the process is designed to focus on life cycle stages showing the greatest sensitivity in order to protect all life stages of the entire aquatic community. In the final derivation of the criterion, the effect level for the chemical is based on the most sensitive stage of the organism’s life cycle. This process provides adequate protection for this "most sensitive portion of the life cycle," and additional protection for all the other life cycle stages.

3. *Use of Conservative Assumptions if Few Data Are Available.* If the number of data points available to develop criteria are relatively few (but the minimum data requirements are satisfied) the calculations used to derive the criteria result in more restrictive values. This conservative approach is expected to provide the appropriate level of protection for aquatic species where toxicity data are lacking.

Using the exposure assumptions discussed above to derive ambient numerical aquatic life criteria results in criteria that are protective of most species most of the time in most waters. On the other hand, a variety of other options exist for States and Tribes to ensure adequate protection for all species in all bodies of water.

3.3 Protective Assumptions Contained in Narrative and Other Water Quality Criteria and Standards that Pertain to Cyanide

Most water quality criteria are developed by EPA, and most criteria are numeric, as indicated above. The CWA requires States and Tribes to adopt criteria where EPA has published section 304(a) guidance (i.e., priority pollutants). The criteria may be numerical or narrative. Narrative criteria can be used so long as the State/Tribe identifies how they intend to regulate point source discharge of the pollutant. Still other equally protective options are available to derive criteria that reflect local or site-specific conditions.

Narrative Criteria:

Narrative criteria provide a qualitative benchmark for assessing water quality. They are useful when particular pollutants or water conditions cannot be precisely measured. Narrative often include the term “free from” in State water quality standards. For example, the term “No Toxics in Toxic Amounts,” is often found in States water quality standards. It can be used to limit a pollutant on a case-by-case basis when no specific numerical standard exists for the chemical. Many States and Tribes water quality standards include both numeric and narrative criteria for section 304(a) pollutants. The use of both ensures that a waterbody is fully protected for both chemical-specific effects and the effects of mixtures of chemicals or other less measurable pollutants.

Biological Criteria:

Where numeric criteria are not available, States and Tribes may adopt criteria based on biological assessment and monitoring methods. Biological assessment is an evaluation of the biological conditions of a waterbody using biological surveys (periphyton, benthic macroinvertebrates, fish) of the structure and function of the resident living organisms. Biological criteria are narrative descriptions or numeric values that are established to protect the biological conditions of the aquatic life inhabiting waters of a given designated use. Degree of impairment (criteria attainment) is done by specifying what aquatic community structure and function should exist in waters of a given designated use, and then by comparing this condition with the condition of a site under evaluation having the same designated use. This permits the detection of impacts from any possible stressor, including the point-source discharge of a chemical-specific pollutant such as cyanide. Having biological criteria provides a second layer of protection (over water quality criteria), and therefore, allows the detection of possible impacts if water quality criteria at a particular site do not appear adequately protective.

Site-Specific Criteria:

The section 304(a) criteria were developed by EPA under the assumptions that the species contained in the data set and the water quality conditions used in the toxicity tests result in criteria that are protective of species in all waterbodies. Because site-specific conditions exist where the resident species may be more or less sensitive than those in the data set, and the water quality conditions may render the pollutant more or less toxic, EPA recommends States and Tribes develop site-specific criteria. EPA has provided guidance on three methods on how to develop site-specific criteria: the recalculation procedure, the resident species procedure, and the water-effect ratio procedure.

States and Tribes have drafted language in their water quality standards related to the development of site-specific criteria as they relate to threatened or endangered species. In Minnesota for example, the State must modify both aquatic life and wildlife standards or develop criteria on a site-specific basis to protect threatened or endangered species where the water quality jeopardizes the continued existence of such species or results in the destruction or adverse modification of such species' critical habitat.

Implementation of narrative and other ambient aquatic life criteria by States and Tribes also results in criteria that are fully protective of most species most of the time in most waters. It is well understood, however, that not every field exposure scenario can be accounted for in nature. Therefore, several other assumptions are made when allocating pollutants (for permitting purposes) among point source discharges to ensure adequate protection for all species in all bodies of water.

3.4 Protective Assumptions Used in Applying Criteria for Waterbodies

When applying criteria, narrative or otherwise, for a waterbody for a specific pollutant among individual or multiple discharges, routine assumptions are made to provide a consistent approach for avoiding exceedances of the water quality criteria in the waterbody. In many cases, these allocations are incorporated into a formal Total Maximum Daily Load (TMDL) that must be established in accordance with requirements of the CWA.

A key tool used in pollutant allocations and TMDLs is the National Pollutant Discharge Elimination System (NPDES) permitting system for point source discharges. Each wastewater discharger must apply for and obtain an NPDES permit, which contains limitations needed to protect the uses of the receiving waters, including aquatic life. A number of assumptions and standard mechanisms are needed to consistently translate a State or Tribal water quality standard into permit discharge limits.

Permit to Discharge Process:

Most States and Tribes use the following assumptions, or similar ones, for these allocation and permitting actions in order to fully protect aquatic life:

1. *Assume that all Dischargers are Discharging the Contaminant at the Maximum Permitted Levels.* Based on conditions specified in permits, each individual discharger is allowed to discharge up to the maximum amount of each specific pollutant allowed in the discharger's NPDES permit. Therefore, that maximum discharge assumption is made when allocating the assimilative capacity of the stream. This approach avoids situations where the water quality standards are exceeded due to the overlapping effects of multiple dischargers. Thus, adequate protection is provided when all dischargers in a stream segment are simultaneously discharging the maximum contaminant load allowed by their permits. It follows naturally then, that additional protection is provided when any or all of the dischargers are discharging the pollutant at lesser amounts than the maximum allowed by the permits.

2. *Provide for an Unallocated "Margin of Safety" When Developing TMDLs.* Whenever a formal TMDL is established, a portion of the assimilative capacity of the waterbody is set aside

as a "margin of safety" for the particular pollutant that is the subject of the TMDL. This is an EPA requirement which provides extra protection for receiving waters.

3. *Assume the Maximum Permitted Discharge Volume.* Each NPDES permit applicant must apply to discharge a certain type and volume of wastewater, which is then limited in the discharger's permit. The limits for pollutants included in the permit are based on achieving the water quality standards in the receiving water when the maximum permitted volume is continuously discharged. This assumption provides adequate protection at maximum discharge rates, and additional protection at all times when discharge rates are lower than the permitted flow.

4. *Assume the Maximum Concentration or Loading of Pollutants.* As stated in Item 1, the NPDES permit limits the concentration of each permitted pollutant to achieve the water quality standards in the receiving water. This provides adequate protection when the discharge contains the maximum concentration of the pollutant, and additional protection at all times when the discharge contains lower amounts.

5. *Assume No Environmental Degradation of Pollutants.* Many pollutants in surface waters will degrade into less harmful degradation products over time (sometimes called "environmental transformation"). This process is quantified by the characteristic "environmental half life" of the pollutant. Persistent pollutants (which are often bioaccumulative) have longer environmental half lives than those pollutants which are less persistent. The assumption that there is no environmental degradation is normally used when calculating permit limits. This provides adequate protection for extremely persistent pollutants, and additional protection for all of those contaminants which are less persistent in the environment.

6. *Assume All Discharged Pollutants Remain Biologically Available.* The bioavailability of pollutants is frequently reduced by the pollutant adhering to solids, volatilizing into the atmosphere, complexing with other constituents of the effluent or surface waters or degrading through biological action. The assumption is normally made that all discharged pollutants remain biologically available in the receiving waters. Contemporary research has shown that the bioavailability of most regulated pollutants is affected considerably by various environmental fate processes. By assuming complete bioavailability, adequate aquatic life protection is provided for those pollutants which remain entirely biologically available, and additional aquatic life protection for all other pollutants.

7. *Assume Receiving Stream Flows are Very Low.* By their very nature, streams have time-variable flow rates. In order to determine the amount of dilution available so that NPDES permit limits can be consistently calculated for discharges to streams, "receiving waterbody flows" must be established. Receiving waterbody flows are established using a number of statistical/hydrological approaches, such as the "seven-day, once in ten year drought flow" (7Q10), the "ninety- day, once in ten year drought flow" (90Q10), or the 95% exceedance flow. The concept is to choose a sufficiently low waterbody flow such that the flow is very rare. This

procedure provides adequate protection at the design low flow conditions, and additional protection at all higher flows.

8. *Assume that Acute Toxicity Limits Apply at the "End of the Pipe."* For many States, the water quality standards needed to protect against acutely toxic effects must be achieved in all areas of the receiving waters. Therefore, permit limits needed to protect for those standards must be met "at the end of the discharge pipe," and no receiving water dilution or mixing zone is used when permit limits are calculated. This approach provides adequate protection against acute toxicity for aquatic species in close proximity to discharges, and additional protection in all other areas of the receiving waterbody.

9. *Assume that Only a Portion of the Design Flow is Available for Mixing for Controls on Chronic Toxicity.* As stated above, the water quality standards needed to protect against acutely toxic effects can apply in all areas of the receiving waters. The water quality standards needed to protect against chronic effects are intended to apply in the receiving waters after mixing. Often only a portion (perhaps 25%) of the low receiving waterbody flow is allowed for dilution when calculating the chronic limits. This is done in order to allow passage of fish and other mobile aquatic species without spending time in the mixing zone. This procedure further reduces the volume of the receiving stream which is used for permitting purposes, and therefore provides additional protection to aquatic species from chronic effects.

10. *Assume that Aquatic Species Live Continuously at the "Edge of the Mixing Zone" for Controls on Chronic Toxicity.* The point where mixing of the discharge with 25% (or other specified portion) of the low flow is complete is often called the "edge of the mixing zone." The edge of the mixing zone cannot be drawn on a map because the shape of the mixing zone is time variable, based on currents and wind speed and direction. Nevertheless, the concept is useful in discussing where chronic standards are met. The permit limits are calculated assuming that chronic water quality standards are met after mixing (at the edge of the mixing zone). Since mobile species such as fish do not stay at the same point in streams, they will not stay at the edge of the mixing zone, and in fact may have an instinct to avoid such areas. Thus, as the fish or other mobile species move away from the mixing zone, they have additional protection.

Of course, this additional protection is not available for immobile species such as shellfish. The standards address this issue by requiring more restrictive mixing zones in order to protect endangered or threatened species. Special mixing zone requirements of this type must be established on a case-by-case basis. Also, in the Great Lakes, mixing zones for certain highly persistent chemicals must be phased out in future years. These mixing zone exceptions provide additional protections for aquatic species.

11. *May Assume No Internal Dilution of Process Wastewater.* In situations where a discharger mixes process wastewater with another wastewater of better quality, such as cooling water, the monitoring points on the two waste streams may be before mixing. The dilution from the cooling water is often assumed to be zero. This assumption provides adequate protection when

the cooling water is not being discharged, and greater protection during all other times when it is being discharged.

12. *May Assume Conservative Values for Upstream Concentrations of Pollutants*. When determining the concentration after mixing between the discharge and stream water, the upstream concentrations of specific pollutants may not be negligible. These concentrations often vary with time, and are difficult to quantify. Conservative assumptions of higher background concentrations designed to provide adequate protection are often used and additional protection is provided at all actual background concentrations which are lower.

13. *Antibacksliding*. This concept is found at Section 402(o) of the CWA. In simple terms, it requires that if a discharger is achieving a permit limit, that limit should not be relaxed in a subsequent permit reissuance action, unless certain restrictive exceptions can be met. Therefore, it may result in limits more restrictive than needed to protect aquatic life.

14. *Antidegradation*. Although this concept does not normally form the basis for permit limits, it may result in permit denial and therefore no new discharge of pollutants in certain cases.

15. *Assume Low Threshold for "Reasonable Potential" if Few Data Are Available.* The term "reasonable potential" for exceeding water quality standards is used to describe when discharge limits are needed for specific pollutants. Reasonable potential is determined to exist at lower concentrations of pollutant in a discharge if fewer data are available to adequately determine the variability of the discharge. This results in a lower threshold for inclusion of a limit in the permit, although it does not result in a more restrictive limit. This provides additional protection in situations where limits might otherwise be left out of permits.

3.5 Monitoring Programs to Assess Attainment of Water Quality Standards

State and Tribal water quality monitoring programs find waterbodies that the State or Tribe determine are “impaired” due to pollution. When a State or Tribe makes this determination, it is typically because the monitoring data indicates that a designated use is not being met or pollutant concentrations in the waterbody exceed the State’s or Tribe’s water quality criteria. These waterbodies are typically listed on CWA section 303(d) lists and reported to EPA as impaired waterbodies for which control efforts will be implemented. The section 303(d)(1) list includes all waterbodies which would not meet the standards without water quality-based limits, and the section 303(d)(4) list includes all waterbodies which are not yet meeting the water quality standards. These latter lists are the so-called "non-attainment lists," which are often based on State monitoring results. Given this process, it is sometimes erroneously concluded that since a waterbody is listed for a pollutant, the chemical concentrations in the waterbody are constantly at or above the criteria value all the time and everywhere within the waterbody. In essence, a simplified worst-case maximum exposure situation is assumed. For most, if not all such waterbodies, this would be an exaggerated assumption due to a number of factors and characteristics of State and Tribal monitoring programs from which data is generated to make impairment and listing decisions.

The monitoring programs vary a great deal from State to State and even from place to place in a given State. Sometimes the data are very complete, but more often they are incomplete and based only on infrequent grab samples. A considerable amount of professional judgment is used in preparing the section 303(d)(4) lists. Furthermore, additional judgment is required because these lists may include both areas known to violate the water quality standards, as well as those which are only close to violating the water quality standards.

It should be noted that most non-attainment areas shown on the section 303(d)(4) lists are not due to inadequate NPDES permits for industrial and municipal point source discharges. This is because the permits cannot be issued if they are not adequately protective. Instead, factors such as non-point source runoff, atmospheric inputs, leaching from historic polluted sediments, and similar difficult-to-control pollutant sources are the usual causes of non-attainment areas.

4.0 PRELIMINARY TOXICITY ASSESSMENT

4.1 Overview

The preliminary toxicity assessment of the risks that the section 304(a) aquatic life criteria pose to listed species consists of two components. The first component addresses toxicity of the criterion chemical to the listed species. For aquatic species, this must consider both if the CMC is adequately protective of acute mortality and if the CCC is protective of various effects in longer exposures. This first component should examine not only standard "water-only" toxicity tests (exposures originating from dissolved chemical added to test water), but also tests in which other routes of exposure are evaluated. For aquatic-dependent species, this assessment addresses effects expected from a diet of aquatic organisms contaminated with the criterion chemical to levels that would result from criteria water concentrations. The second component of the assessment addresses toxicity of the criterion chemical to the food items of listed species to determine if any listed species are likely to be affected by a loss of food.

The preliminary toxicity assessment applies existing toxicological information to determine whether EPA's recommended section 304(a) criteria for cyanide is likely to adversely affect each listed species. If screened out in the preliminary toxicity assessment, the species/chemical combination must have an acceptably low risk under all circumstances, and not require any further attention. EPA has a high degree of confidence when making a "not likely to adversely affect" determination for those species which are screened out in the preliminary toxicity assessment. In contrast, species and chemical combinations that are not screened out in the preliminary toxicity assessment require additional consideration and analysis to determine under what circumstances risks are unacceptable. In this document, this additional consideration and analysis consists of the secondary toxicity assessment and the exposure assessment. Therefore, the preliminary toxicity assessment acts as a conservative screen, premised on a null hypothesis that the criteria might constitute a risk to an endangered species, with a low probability for erroneously rejecting this hypothesis.

In all cases, the preliminary toxicity assessment methodology for any particular organism and endpoint is based on a simple risk ratio:

$$R = C_A/EC_A$$

where C_A is the "assessment exposure concentration" (based on what exposure concentrations are allowed by the criterion) and EC_A is the "assessment effects concentration" (the concentration that represents a maximum level of effect considered acceptable). If $C_A < EC_A$ (i.e., $R<1$), the chemical concentration is expected to be less than the effects concentration. Thus, the species would be screened out from further analysis and a determination of "not likely to adversely affect" would be made. Otherwise, if $C_A > EC_A$ (i.e., $R>1$), the chemical concentration is expected to be at or above the effects concentration, and the species is not screened out in the preliminary toxicity assessment. For these species, EPA then conducts a secondary toxicity assessment and an exposure assessment in order to make a determination of whether EPA's recommended section 304(a) criteria for cyanide is "likely to adversely affect" those species.

For more details on the preliminary toxicity assessment, see Section 3.1 of the *BE Methods Manual*.

4.2 Data Collection

The acute and chronic cyanide toxicity data used in this biological evaluation were collected from a literature search of EPA's ECOTOX database, EPA's Ambient Aquatic Life Water Quality Criteria for Cyanide (U.S. EPA 1984), and data provided by the Services and EPA regional and field offices. The complete literature search and data review strategy is included in Section 3.2 and Appendices D and E of the *BE Methods Manual*. In addition, for this cyanide biological evaluation, data were also collected through a search of POLTOX and TOXLINE Plus. Articles containing data rejected for use in this analysis are provided in Appendix C of this biological evaluation.

4.3 Toxic Effects on Aquatic Species

This section presents the toxicity data and the preliminary toxicity assessment for assessing effects of cyanide at criteria concentrations on Federally-listed aquatic species, their surrogates, and their food items. Toxicity tests on aquatic species generally involve exposures in which a test chemical is initially dissolved in water, with exposure via other routes (such as food) occurring to the extent that they are incidentally contaminated by contact with the exposure water. The overall process for assessing aquatic toxicity is described in detail in the *BE Methods Manual*, Section 3.3. The results of the preliminary toxicity assessment for aquatic species is located in Table 4 in this document which corresponds to Table 4.1 in the *BE Methods Manual*.

4.3.1 Aquatic Animals

This section consists of the assessment results for water-column only toxicity to aquatic animals. The process for assessing the effects from water only exposure is described in Section 3.3.1 of the *BE Methods Manual*. Aquatic data for the assessment are presented in Table 1 as values for a given species. Table 1 in this document corresponds to Table 3.1 in the *BE Methods Manual*. These data are then used to derive the mean and 5th percentile values for specific taxa in Tables 2 and 3. These two tables in this document correspond to Table 3.2 in the *BE Methods Manual*. Several aspects of the assessment are worth noting here: (1) Except where otherwise indicated, the no-observed effect concentrations (NOECs) in Table 1 are from either (a) chronic tests where cyanide in the exposure medium was measured or (b) are derived from acute tests through acute-to-chronic ratios (ACRs; see Appendix B for the derivation of ACRs used in this biological evaluation); and (2) taxa in Tables 2 and 3 are given a 5th percentile value only where there are four or more data points for the taxon, where an Interspecies Correlation Estimate (ICE) is available (see Appendix A) for the taxon, and/or where a 5th percentile value was derived via an alternative approach for the taxon. All calculations are rounded to four significant digits to prevent rounding error, however, this may introduce other error since this is not always in keeping with the number of significant digits in the original data.

Table 1. Toxicity data obtained through the literature search. Unless otherwise indicated LC50s are from acute tests. NOECs are either "Measured NOECs" from chronic tests or "Estimated NOECs" derived via acute-chronic ratios (ACRs) from acute LC50s. The ACR is 10.57 for fish, 8.889 for freshwater invertebrates, and 2.384 for saltwater invertebrates. A "Lower Bound or Range LC50" entry indicates the species is a Federally-listed species.												
Reference	**Phylum**	**Class**	**Order**	**Family**	**Genus**	**Species**	**Common Name**	**Mean LC50 (µg/L)**	**Lower Bound or Range LC50 (µg/L)**	**Measured NOEC (µg/L)**	**Estimated NOEC (µg/L)**	**Saltwater Toxicity Test?[c]**
1	Annelida	Clitellata	Lumbriculida	Lumbriculidae	Lumbriculus	variegatus[a]	Oligochaete	11149			1255	
2	Annelida	Polychaeta	Scolecida	Aeolosomatidae	Aeolosoma	headleyi	Oligochaete	160000			18009	
3,1	Arthropoda	Branchiopoda	Diplostraca	Daphniidae	Daphnia	magna	Water flea	120			13.51	
2,4	Arthropoda	Branchiopoda	Diplostraca	Daphniidae	Daphnia	pulex	Water flea	95.55			10.75	
5	Arthropoda	Branchiopoda	Diplostraca	Daphniidae	Daphnia	sp.	Water flea	169			19.02	
5	Arthropoda	Insecta	Coleoptera	Dytiscidae	Dytiscus	sp.	Diving beetle	250			28.14	
6	Arthropoda	Insecta	Diptera	Chironomidae	Tanytarsus	dissimilis	Midge	2420			272.4	
7	Arthropoda	Insecta	Ephemeroptera	Heptageniidae	Stenonema	rubrum	Mayfly	500			56.28	
5	Arthropoda	Insecta	Heteroptera	Corixidae	Corixa	sp.	Water boatman	251			28.25	
5	Arthropoda	Insecta	Heteroptera	Nepidae	Nepa	sp.	Water scorpion	294			33.09	
5	Arthropoda	Insecta	Heteroptera	Nepidae	Ranatra	sp.	Water scorpion	231			26.00	
8	Arthropoda	Insecta	Plecoptera	Pteronarcyidae	Pteronarcys	dorsata	Stonefly	436			49.07	
7	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsyche	betteni	Caddisfly	2000			225.1	
9	Arthropoda	Malacostraca	Amphipoda	Ampeliscidae	Ampelisca	abdita	Amphipod	995.9			417.7	Yes
1	Arthropoda	Malacostraca	Amphipoda	Gammaridae	Gammarus	fasciatus	Scud	903			101.6	
10,11	Arthropoda	Malacostraca	Amphipoda	Gammaridae	Gammarus	pseudolimnaeus	Scud	142.9		16.08		
12	Arthropoda	Malacostraca	Decapoda	Atyidae	Caridina	nilotica[a]	Shrimp	316			35.57	
13	Arthropoda	Malacostraca	Decapoda	Cancridae	Cancer	gracilis	Graceful rock crab	143.7			60.28	Yes
14	Arthropoda	Malacostraca	Decapoda	Cancridae	Cancer	irroratus	Rock crab	4.893			2.052	Yes
13	Arthropoda	Malacostraca	Decapoda	Cancridae	Cancer	magister	Dungeness crab	68.50			28.73	Yes
13	Arthropoda	Malacostraca	Decapoda	Cancridae	Cancer	oregonensis	Pigmy rock crab	130.7			54.84	Yes
13	Arthropoda	Malacostraca	Decapoda	Cancridae	Cancer	productus	Red crab	153.1			64.21	Yes
15	Arthropoda	Malacostraca	Decapoda	Penaeidae	Penaeus	monodon	Jumbo tiger prawn	110			46.14	Yes
10,11	Arthropoda	Malacostraca	Isopoda	Asellidae	Asellus	communis	Aquatic sowbug	2297		29.02		
1	Arthropoda	Malacostraca	Isopoda	Asellidae	Asellus	intermedius	Aquatic sowbug	1699			191.2	
16,17	Arthropoda	Malacostraca	Mysida	Mysidae	Americamysis	bahia	Opossum shrimp	102.5		43		Yes
18	Arthropoda	Malacostraca	Mysida	Mysidae	Leptomysis	mediterranea[a]	Opossum shrimp	37.0			15.52	Yes
16	Arthropoda	Malacostraca	Mysida	Mysidae	Mysidopsis	bigelowi	Shrimp	123.6			51.84	Yes
16	Arthropoda	Maxillipoda	Calanoida	Acartiidae	Acartia	clausi	Calanoid copepod	17			7.131	Yes
5	Arthropoda	Maxillipoda	Calanoida	Diaptomidae	Diaptomus	sp.	Calanoid copepod	173			19.47	
5	Arthropoda	Maxillipoda	Cyclopoida	Cyclopidae	Cyclops	viridis	Cyclopoid copepod	167			18.80	
19,20,21	Chlorophyta	Chlorophyceae	Chlorococcales	Scenedesmaceae	Scenedesmus	quadricauda	Green algae			98.65		

Table 1. Toxicity data obtained through the literature search. Unless otherwise indicated LC50s are from acute tests. NOECs are either "Measured NOECs" from chronic tests or "Estimated NOECs" derived via acute-chronic ratios (ACRs) from acute LC50s. The ACR is 10.57 for fish, 8.889 for freshwater invertebrates, and 2.384 for saltwater invertebrates. A "Lower Bound or Range LC50" entry indicates the species is a Federally-listed species.												
Reference	**Phylum**	**Class**	**Order**	**Family**	**Genus**	**Species**	**Common Name**	**Mean LC50 (µg/L)**	**Lower Bound or Range LC50 (µg/L)**	**Measured NOEC (µg/L)**	**Estimated NOEC (µg/L)**	**Saltwater Toxicity Test?[c]**
22	Chlorophyta	Trebouxiophyceae	Chlorellales	Chlorellaceae	Prototheca	zopfii	Green algae			3000		
23	Chordata	Actinopterygii	Atheriniformes	Atherinidae	Menidia	menidia	Atlantic silverside	59.3			5.608	Yes
24	Chordata	Actinopterygii	Cypriniformes	Cyprinidae	Carassius	auratus	Goldfish	318			30.07	
5	Chordata	Actinopterygii	Cypriniformes	Cyprinidae	Catla	catla[a]	Catla	918			86.82	
5	Chordata	Actinopterygii	Cypriniformes	Cyprinidae	Cirrhinus	mrigala[a]	Carp, hawk fish	839			79.34	
25	Chordata	Actinopterygii	Cypriniformes	Cyprinidae	Cyprinus	carpio	Common carp			73		
26	Chordata	Actinopterygii	Cypriniformes	Cyprinidae	Danio	rerio	Zebra danio	490			46.34	
5	Chordata	Actinopterygii	Cypriniformes	Cyprinidae	Labeo	bata[a]	Fish	1970			186.3	
5	Chordata	Actinopterygii	Cypriniformes	Cyprinidae	Labeo	calbasu[a]	Carp	1030			97.41	
5	Chordata	Actinopterygii	Cypriniformes	Cyprinidae	Labeo	rohita[a]	Rohu	1046			98.92	
1,27,28,29, 30,31,32	Chordata	Actinopterygii	Cypriniformes	Cyprinidae	Pimephales	promelas	Fathead minnow	138.4		10.68		
33	Chordata	Actinopterygii	Cypriniformes	Cyprinidae	Rutilus	rutilus[a]	Roach	108.1			10.22	
34	Chordata	Actinopterygii	Cypriniformes	Cyprinidae	Tanichthys	albonubes[a]	Mountain minnow	424.9			40.18	
35	Chordata	Actinopterygii	Cyprinodontiformes	Cyprinodontidae	Cyprinodon	variegatus	Sheepshead minnow	300		29		Yes
36	Chordata	Actinopterygii	Cyprinodontiformes	Cyprinodontidae	Jordanella	floridae	Flagfish	559.5		66.84		
12,37,38	Chordata	Actinopterygii	Cyprinodontiformes	Poeciliidae	Gambusia	affinis	Western mosquitofish	511.9			48.41	
39,40	Chordata	Actinopterygii	Cyprinodontiformes	Poeciliidae	Poecilia	reticulata	Guppy	187.8			17.76	
30,31,41,4,2, 43,44,45	Chordata	Actinopterygii	Perciformes	Centrarchidae	Lepomis	macrochirus	Bluegill	126.1		9.434		
11	Chordata	Actinopterygii	Perciformes	Centrarchidae	Micropterus	salmoides	Largemouth bass	101.7			9.618	
11	Chordata	Actinopterygii	Perciformes	Centrarchidae	Pomoxis	nigromaculatus	Black crappie	101.9			9.637	
46	Chordata	Actinopterygii	Perciformes	Cichlidae	Cichlasoma	bimaculatum	Black acara	135		110		
5	Chordata	Actinopterygii	Perciformes	Cichlidae	Tilapia	mossambica	Mozambique tilapia	1046			98.92	
47	Chordata	Actinopterygii	Perciformes	Gobiidae	Boleophthalmus	boddarti[a]	Goggle-eye goby	296.1			28.00	Yes
48	Chordata	Actinopterygii	Perciformes	Percichthyidae	Macquaria	novemaculeata[a]	Australian bass	109			10.31	Yes
31	Chordata	Actinopterygii	Perciformes	Percidae	Perca	flavescens	Yellow perch	92.70			8.767	
33	Chordata	Actinopterygii	Perciformes	Percidae	Perca	fluviatilis[a]	Perch	96			9.079	
48	Chordata	Actinopterygii	Perciformes	Sparidae	Acanthopagrus	butcheri[a]	Black bream	70			6.620	Yes
49	Chordata	Actinopterygii	Pleuronectiformes	Pleuronectidae	Pseudopleuronectes	americanus	winter flounder	372			35.18	Yes
31,50,51,52,5 3,54,55,56	Chordata	Actinopterygii	Salmoniformes	Salmonidae	Oncorhynchus	mykiss[b]	Rainbow trout	59.22	27.3–97.6 (n=18)	9.799		
57	Chordata	Actinopterygii	Salmoniformes	Salmonidae	Salmo	salar[b]	Atlantic salmon	90	-[d]		8.514	

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Reference	**Phylum**	**Class**	**Order**	**Family**	**Genus**	**Species**	**Common Name**	**Mean LC50 (µg/L)**	**Lower Bound or Range LC50 (µg/L)**	**Measured NOEC (µg/L)**	**Estimated NOEC (µg/L)**	**Saltwater Toxicity Test?[c]**
24,32,58	Chordata	Actinopterygii	Salmoniformes	Salmonidae	Salvelinus	fontinalis	Brook trout	85.74		5.641		
19	Cyanophycota	Cyanophyceae	Chroococcales	Chroococcaceae	Microcystis	aeruginosa	Blue-green algae			70		
59	Magnoliophyta	Liliopsida	Arales	Lemnaceae	Lemna	gibba	Inflated duckweed			26000		
60	Magnoliophyta	Magnoliopsida	Haloragales	Haloragaceae	Myriophyllum	spicatum	Myriophylle en epi			22400		
18	Mollusca	Bivalvia	Mytiloida	Mytilidae	Mytilus	galloprovincialis	Mediterranean mussel	10.6			4.446	Yes
61	Mollusca	Bivalvia	Ostreoida	Pectinidae	Chlamys	asperrimus[a]	Doughboy scallop	28.6			12.00	Yes
62	Mollusca	Gastropoda	Archaeogastropoda	Haliotididae	Haliotis	varia[a]	Variable Abalone	1012			424.5	Yes
5	Mollusca	Gastropoda	Architaenioglossa	Ampullariidae	Pila	globosa[a]	Apple snail	1540			173.3	
5	Mollusca	Gastropoda	Architaenioglossa	Viviparidae	Viviparus	bengalensis[a]	Snail	1577			177.5	
63	Mollusca	Gastropoda	Basommatophora	Lymnaeidae	Lymnaea	emarginata	Pond snail	3300			371.4	
5	Mollusca	Gastropoda	Basommatophora	Lymnaeidae	Lymnaea	leuteola[a]	Pond snail	1343			151.2	
41	Mollusca	Gastropoda	Basommatophora	Physidae	Physa	heterostropha	Snail	432			48.62	
64	Mollusca	Gastropoda	Basommatophora	Physidae	Physa	integra	Pouch snail	1350			151.9	
1	Mollusca	Gastropoda	Basommatophora	Planorbidae	Planorbella	trivolvis	Ramshorn snail	53091			5976	
5	Mollusca	Gastropoda	Cephalaspidea	Bullinidae	Indoplanorbis	exustus[a]	Snail	1550			174.5	
65	Mollusca	Gastropoda	Neotaenioglossa	Calyptraeidae	Crepidula	fornicata	Slipper limpet	10000			4195	Yes
2	Mollusca	Gastropoda	Neotaenioglossa	Pleuroceridae	Anculosa	sp.	Snail	8000			900.4	
64	Mollusca	Gastropoda	Neotaenioglossa	Pleuroceridae	Elimia	livescens	River snail	760000			85540	
1,66	Platyhelminthes	Turbellaria	Tricladida	Planariidae	Dugesia	tigrina	flatworm	2419			272.4	
67	Rhodophycota	Rhodophyceae	Rhodymeniales	Champiaceae	Champia	parvula	Red algae			11		Yes
68	Rotifera	Monogononta	Ploima	Brachionidae	Brachionus	calyciflorus	Rotifer	62448			7029	

[a] Indicates non-North American species.

[b] Indicates Federally-listed species.

[c] Indicates that the toxicity values for the species were from tests conducted in saltwater.

[d] Lower bound LC50 value not available for this Federally-listed species.

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Table 2. Freshwater toxicity data by taxonomic group. The 5th percentile values are the basis for those effects concentrations (EC_As) in Table 4 that rely on surrogate data. The approach used for the 5th percentile values is indicated in superscript.									
Phylum	**Class**	**Order**	**Family**	**Genus**	**N**	**Mean LC_{50} (µg/L)**	**Mean NOEC (µg/L)**	**5th % LC_{50} (µg/L)**	**5th % NOEC (µg/L)**
Annelida					2	42236	4754		
	Clitellata				1	11149	1255		
		Lumbriculida			1	11149	1255		
			Lumbriculidae		1	11149	1255		
				Lumbriculus	1	11149	1255		
	Polychaeta				1	160000	18009		
		Scolecida			1	160000	18009		
			Aeolosomatidae		1	160000	18009		
				Aeolosoma	1	160000	18009		
Arthropoda					18	388.2	38.69	99.62[b]	11.21[b]
	Branchiopoda				3	124.7	14.03		
		Diplostraca			3	124.7	14.03		
			Daphniidae		3	124.7	14.03		
				Daphnia	3	124.7	14.03		
	Insecta				8	508.9	57.28	216.2[b]	24.34[b]
		Coleoptera			1	250	28.14		
			Dytiscidae		1	250	28.14		
				Dytiscus	1	250	28.14		
		Diptera			1	2420	272.4		
			Chironomidae		1	2420	272.4		
				Tanytarsus	1	2420	272.4		
		Ephemeroptera			1	500	56.28		
			Heptageniidae		1	500	56.28		
				Stenonema	1	500	56.28		
		Heteroptera			3	257.4	28.97		
			Corixidae		1	251	28.25		
				Corixa	1	251	28.25		
			Nepidae		2	260.6	29.33		
				Nepa	1	294	33.09		
				Ranatra	1	231	26		
		Plecoptera			1	436	49.07		
			Pteronarcyidae		1	436	49.07		
				Pteronarcys	1	436	49.07		
		Trichoptera			1	2000	225.1		

Table 2. Freshwater toxicity data by taxonomic group. The 5th percentile values are the basis for those effects concentrations (EC_As) in Table 4 that rely on surrogate data. The approach used for the 5th percentile values is indicated in superscript.

Phylum	Class	Order	Family	Genus	N	Mean LC_{50} (µg/L)	Mean NOEC (µg/L)	5th % LC_{50} (µg/L)	5th % NOEC (µg/L)
			Hydropsychidae		1	2000	225.1		
				Hydropsyche	1	2000	225.1		
	Malacostraca				5	692.4	50.32	66.57[b]	8.53[b]
		Amphipoda			2	359.2	40.43		
			Gammaridae		2	359.2	40.43		
				Gammarus	2	359.2	40.43	34.81[a]	3.918[a]
		Decapoda			1	316	35.57		
			Atyidae		1	316	35.57		
				Caridina	1	316	35.57		
		Isopoda			2	1976	74.49		
			Asellidae		2	1976	74.49		
				Asellus	2	1976	74.49		
	Maxillipoda				2	170.0	19.13		
		Calanoida			1	173	19.47		
			Diaptomidae		1	173	19.47		
				Diaptomus	1	173	19.47		
		Cyclopoida			1	167	18.8		
			Cyclopidae		1	167	18.8		
				Cyclops	1	167	18.8		
Chordata					23	267.2	27.74	66.46[b]	6.39[b]
	Actinopterygii				23	267.2	27.74	66.46[b]	6.39[b]
		Cypriniformes			10	525.9	48.74	84.55[b]	7.72[b]
			Cyprinidae		10	525.9	48.74	106.8[a]	10.10[a]
				Carassius	1	318	30.07		
				Catla	1	918	86.82		
				Cirrhinus	1	839	79.34		
				Danio	1	490	46.34		
				Labeo	3	1285	121.5		
				Pimephales	1	138.4	10.68		
				Rutilus	1	108.1	10.22		
				Tanichthys	1	424.9	40.18		
		Cyprinodontiformes			3	377.5	38.59		
			Cyprinodontidae		1	559.6	66.84	139.7[a]	13.21[a]
				Jordanella	1	559.6	66.84		
			Poeciliidae		2	310.1	29.32		

Table 2. Freshwater toxicity data by taxonomic group. The 5th percentile values are the basis for those effects concentrations (EC_As) in Table 4 that rely on surrogate data. The approach used for the 5th percentile values is indicated in superscript.									
Phylum	**Class**	**Order**	**Family**	**Genus**	**N**	**Mean LC_{50} (µg/L)**	**Mean NOEC (µg/L)**	**5th % LC_{50} (µg/L)**	**5th % NOEC (µg/L)**
				Gambusia	1	511.9	48.41		
				Poecilia	1	187.8	17.76		
		Perciformes			7	149.2	18.56	90.8[b]	8.57[b]
			Centrarchidae		3	109.3	9.56		
				Lepomis	1	126.1	9.43		
				Micropterus	1	101.7	9.62		
				Pomoxis	1	101.9	9.64		
			Cichlidae		2	375.8	104.3		
				Cichlasoma	1	135	110		
				Tilapia	1	1046	98.92		
			Percidae		2	94.34	8.92	45.5[a]	4.305[a]
				Perca	2	94.34	8.92		
		Salmoniformes			3	77.03	7.78		
			Salmonidae		3	77.03	7.78		
				Oncorhynchus	1	59.22	9.8	48.6[a]	4.598[a]
				Salmo	1	90	8.51	29.24[a]	2.766[a]
				Salvelinus	1	85.74	5.64	19.57[a]	1.851[a]
Mollusca					10	4464	502.4	408.0[b]	45.92[b]
	Gastropoda				10	4464	502.4	408.0[b]	45.92[b]
		Architaenioglosss			2	1558	175.4		
			Ampullariidae		1	1540	173.3		
				Pila	1	1540	173.3		
			Viviparidae		1	1577	177.5		
				Viviparus	1	1577	177.5		
		Basommatophora			5	2676	301.2	247.4[b]	27.84[b]
			Lymnaeidae		2	2105	237.0		
				Lymnaea	2	2105	237.0		
			Physidae		2	763.7	85.95		
				Physa	2	763.7	85.95		
			Planorbidae		1	53091	5976		
				Planorbella	1	53091	5976		
		Cephalaspidea			1	1550	174.5		
			Bullinidae		1	1550	174.5		
				Indoplanorbis	1	1550	174.5		
		Neotaenioglossa			2	77974	8776		

Table 2. Freshwater toxicity data by taxonomic group. The 5th percentile values are the basis for those effects concentrations (EC_As) in Table 4 that rely on surrogate data. The approach used for the 5th percentile values is indicated in superscript.

Phylum	Class	Order	Family	Genus	N	Mean LC_{50} (µg/L)	Mean NOEC (µg/L)	5th % LC_{50} (µg/L)	5th % NOEC (µg/L)
			Pleuroceridae		2	77974	8776		
				Anculosa	1	8000	900.4		
				Elimia	1	760000	85540		
Platyhelminthes					1	2420	272.4		
	Turbellaria				1	2420	272.4		
		Tricladida			1	2420	272.4		
			Planariidae		1	2420	272.4		
				Dugesia	1	2420	272.4		
Rotifera					1	62448	7029		
	Monogononta				1	62448	7029		
		Ploima			1	62448	7029		
			Brachionidae		1	62448	7029		
				Brachionus	1	62448	7029		

[a] Lower 5th percentile confidence value from Interspecies Correlation Estimate (ICE) from Appendix A
[b] 5th percentile estimate from species sensitivity distribution (SSD)

Table 3. Saltwater toxicity data by taxonomic group. The 5th percentile values are the basis for those effects concentrations (EC_As) in Table 4 that rely on surrogate data. The approach used for the 5th percentile values is indicated in superscript.									
Phylum	**Class**	**Order**	**Family**	**Genus**	**N**	**Mean LC_{50} (µg/L)**	**Mean NOEC (µg/L)**	**5th % LC_{50} (µg/L)**	**5th % NOEC (µg/L)**
Arthropoda					11	79.85	33.49	3.740[b]	1.570[b]
	Malacostraca				10	93.21	39.10	3.750[b]	1.570[b]
		Amphipoda			1	995.9	417.7		
			Ampeliscidae		1	995.9	417.7		
				Ampelisca	1	995.9	417.7		
		Decapoda			6	68.80	28.86	2.890[b]	1.210[b]
			Cancridae		5	62.64	26.27	2.690[b]	1.130[b]
				Cancer	5	62.64	26.27	2.690[b]	1.130[b]
			Penaeidae		1	110.0	46.14		
				Penaeus	1	110.0	46.14		
		Mysida			3	77.68	32.59		
			Mysidae		3	77.68	32.59		
				Americamysis	1	102.5	43.00		
				Leptomysis	1	37.00	15.52		
				Mysidopsis	1	123.6	51.84		
	Maxillipoda				1	17.00	7.130		
		Calanoida			1	17.00	7.130		
			Acartiidae		1	17.00	7.130		
				Acartia	1	17.00	7.130		
Chordata					6	157.0	14.90	32.20[b]	3.040[b]
	Actinopterygii				6	157.0	14.90	32.20[b]	3.040[b]
		Atheriniformes			1	59.30	5.610		
			Atherinidae		1	59.30	5.610		
				Menidia	1	59.30	5.610		
		Cyprinodontiformes			1	300.0	29.00		
			Cyprinodontidae		1	300.0	29.00		
				Cyprinodon	1	300.0	29.00	139.7[a]	13.22[a]
		Perciformes			3	131.2	12.41		
			Gobiidae		1	296.1	28.00		
				Boleophthalmus	1	296.1	28.00		
			Percichthyidae		1	109.0	10.31		
				Macquaria	1	109.0	10.31		
			Sparidae		1	70.00	6.620		
				Acanthopagrus	1	70.00	6.620		

Table 3. Saltwater toxicity data by taxonomic group. The 5th percentile values are the basis for those effects concentrations (EC_As) in Table 4 that rely on surrogate data. The approach used for the 5th percentile values is indicated in superscript.

Phylum	Class	Order	Family	Genus	N	Mean LC_{50} (µg/L)	Mean NOEC (µg/L)	5th % LC_{50} (µg/L)	5th % NOEC (µg/L)
		Pleuronectiformes			1	372.0	35.18		
			Pleuronectidae		1	372.0	35.18		
				Pseudopleuronectes	1	372.0	35.18		
Mollusca					4	235.36	98.72	0.920[b]	0.390[b]
	Bivalvia				2	17.41	7.300		
		Mytiloida			1	10.60	4.450		
			Mytilidae		1	10.60	4.450		
				Mytilus	1	10.60	4.450		
		Ostreoida			1	28.60	12.00		
			Pectinidae		1	28.60	12.00		
				Chlamys	1	28.60	12.00		
	Gastropoda				2	3181	1334		
		Archaeogastropoda			1	1012	424.6		
			Haliotididae		1	1012	424.6		
				Haliotis	1	1012	424.6		
		Neotaenioglossa			1	10000	4195		
			Calyptraeidae		1	10000	4195		
				Crepidula	1	10000	4195		

[a] Lower 5th percentile confidence value from Interspecies Correlation Estimate (ICE) from Appendix A

[b] 5th percentile estimate from species sensitivity distribution (SSD)

4.3.2 Multiple Routes of Exposure

There is no published evidence that cyanide bioaccumulates in fresh- or saltwater aquatic animals. This may be due in part to the widely-held view that low doses are rapidly metabolized and high doses are lethal (Hill and Henry 1996). Because cyanide does not tend to bioaccumulate in aquatic animals, and also because it does not remain biologically available in water or sediments (Eisler, *et al.* 1999), the risk of cyanide to aquatic organisms via other potential routes of exposure, i.e., diet, sediment, etc., is not likely to pose any additional threat to listed species. Accordingly, the added risk factor from other exposure routes, F_R, is not applied in the chronic assessment.

4.3.2.1 Toxicity of Cyanide Exposure Via Diet

No data are available for the assessment of risk to aquatic animals from the consumption of cyanide through their diet. This may be due in part to the fact that studies with simple cyanides show that at sublethal doses, cyanide reacts with thiosulfate in the presence of the enzyme rhodanase, a sulfurtransferase involved in cyanide detoxification, to produce relatively non-toxic thiocyanate, which also happens to be readily excreted in the urine (Eisler, *et al.* 1999; Wiemeyer, *et al.* 1986). With such rapid metabolism and detoxification, the simple cyanides are not likely to accumulate, and therefore, are not subject to extensive bioconcentration in tissue and subsequent biomagnification in the aquatic food web. Moreover, simple cyanides, which are readily hydrolyzed and dissociated in solution as free cyanide, are easily volatilized, especially at more acidic pH (Huiatt, *et al.* 1983). In addition, cyanide in natural waters is usually either complexed by trace metals or metabolized by microorganisms so that significant levels of the toxic free cyanide do not persist (Ballantyne 1987, Eisler 1991, Towhill, *et al.* 1978).

Assignment of Potency Factors for Vertebrates: None

Assignment of Potency Factors for Invertebrates: None

4.3.2.2 Concentration Factors for Food

No new data are available to determine the concentration factors for cyanide from food of aquatic animals, and there currently are no studies showing bioconcentration of cyanide in tissues of aquatic animals (Towill, *et al.* 1978). Cyanide concentrations in tissues of fish from streams poisoned with the chemical only ranged from 10 to 100 µg total CN/ kg whole body wet weight (Wiley 1984). Pennington *et al.* (1982) found no detectable levels of cyanide in four species of fish from a Mississippi lake (detection limit 500 µg CN/kg wet fish tissue). Holden and Marsden (1964) measured the concentration of cyanide in various tissues of salmonids exposed to rapidly lethal cyanide levels, and observed that while cyanide does appear to penetrate aquatic organisms, as noted by the high gill tissue cyanide concentrations ranging from 30 µg total CN/kg wet weight to >7,000 µg total CN/kg wet weight, it cannot be demonstrated to bioaccumulate in whole body tissue. Because cyanide does not bioaccumulate to any significant degree, exposure via consumption of cyanide in food organisms is not significant, and therefore the dietary route of cyanide exposure will not be considered in this analysis.

Assignment of Food Partition Coefficient for Vertebrates: None

Assignment of Food Partition Coefficient for Invertebrates: None

4.3.2.3 Risk Factors for Estimating Toxicity of Multiple Exposure Routes

No food potency or partition coefficients were assigned for aquatic animals, and free cyanide is not generally found in plant cells, nor does any addition of exogenous cyanide appear to cause cyanide to accumulate in plants (Towill, *et al.* 1978). Therefore, a water concentration estimated to be safe for any endangered species based on water-only exposures need not be divided by a F_R to estimate a water concentration that would represent equivalent effects from combined water and food exposures.

One other possible route of exposure is via the sediment, either through ingestion of contaminated sediment by macroinbertebrates, or through direct exposure via interstitial (pore) water. However, no data exist on the toxicity of cyanide in sediments, where cyanide does not appear to remain biologically available, again due complexation by trace metals, microbial degradation, or loss of free cyanide via volatilization (Ballantyne 1987, Eisler 1991, Towhill, *et al.* 1978).

4.3.3 Aquatic Plants

This section consists of the assessment results for water-column only chronic toxicity of cyanide to aquatic plants. As indicated in the *BE Methods Manual*, there are few existing data on acute toxicity to plants at criteria levels for most of the section 304(a) criteria pollutants, and these few data indicate that plants do not demonstrate acute effects at criteria levels. Such is the case with cyanide. Accordingly, the assessment methodology for listed plant species is founded on appropriate measures of chronic toxicity, where: (1) the chronic values for plants (reported as either the NOEC or as the LOEC) in Table 1 are from tests where cyanide in the exposure medium was measured, and (2) the endpoint measured was biologically significant (e.g., vegetative growth or reproduction). Because plants are rarely as sensitive as fish and macroinvertebrates, the recovery rate for phytoplankton is extremely rapid, and because there are few data available on the toxicity to plants, the effects determination for plants is based on a comparison of the chronic criterion to the most sensitive acceptable plant value, freshwater (LOEC for the blue-green algae, *Microcystis aeruginosa*, 70 µg CN/L÷2 = 35 µg CN/L) and saltwater (NOEC for the marine red algae, *Champia parvula* 11 µg CN/L) species, respectively. These most sensitive values are well above the chronic criterion and most likely conservative because they are based on tests with algal species. The only available data for aquatic macrophytes are for *Lemna gibba* (duckweed) and *Myriophylum spicatum* (milfoil) with measured effect concentrations of 26,000 and 22,400 µg CN/L, respectively (Table 1). Consequently, of the 120 aquatic or wetland plant species, EPA will make a "not likely to adversely affect" finding for such species.

Table 4. Results of the Preliminary Screening Toxicity Assessment for Aquatic Listed Species (all units in µg CN/L) (Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L)									
Species	**Saltwater *v.* Freshwater Exposure**	**Order** / **Family**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	**Taxon Represented by EC_A**	**Food Items Analysis[c]** Items	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	**Preliminary Screening Toxicity Assessment Results**
Alabama cave shrimp *Palaemonias alabamae*	FW	Decapoda Atyidae	29.33[S]	8.53[S]	Malacostraca	freshwater detritus and plant matter		99-26,000	Not likely to adversely affect
Alabama cavefish *Speoplatyrhinus poulsoni*	FW	Percopsiformes Amblyopsidae	29.28[S]	6.39[S]	Actinopterygii	freshwater small aquatic inverts; smaller cavefish	42-335,000 26-900	16-29 5.6-110	Not likely to adversely affect
Alabama sturgeon *Scaphirhynchus suttkusi*	FW	Acipenseriformes Acipenseridae	29.28[S]	6.39[S]	Actinopterygii	freshwater crustaceans worms insect larvae fish	42-1,000 1,100-70,000 192-1,100 26-900	16-29 270-18,000 49-272 5.6-110	Not likely to adversely affect
Alabama lampmussel *Lampsilis virescens* (adult)	FW	Unionoida Unionidae	426.62[I]	109.00[I]	*Lampsilis*	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Alabama moccasinshell *Medionidus acutissimus* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Amber darter *Percina antesella*	FW	Perciformes Percidae	20.04[I]	4.30[I]	Percidae	freshwater aquatic insects	192-1,100	49-272	Not screened out
Anthony's riversnail *Athearnia anthonyi*	FW	Neotaenioglossa Hydrobidae	108.99[S]	27.84[S]	Basommatophora	freshwater diatoms and detritus		99-26,000	Not likely to adversely affect
Apache trout *Oncorhynchus apache*	FW	Salmoniformes Salmonidae	9.08[I]	1.95[I]	*Oncorhynchus apache*	yolk sacs; small freshwater inverts; freshwater aquatic and terrestrial insects (Ephemeroptera, Trichoptera, and Diptera)	nd 42-335,000 192-1,100	nd 16-29 49-272	Not screened out
Arkansas River shiner *Notropis girardi*	FW	Cypriniformes Cyprinidae	47.04[I]	10.1[I]	Cyprinidae	fw plankton feeder benthic insects worms	42-28,000 192-1,100 1,100-70,000	11-7,000 49-272 270-18,000	Not likely to adversely affect
Appalachean elktoe *Alasmidonta raveneliana* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Arkansas fatmucket *Lampsilis powelli* (adult)	FW	Unionoida Unionidae	426.62[I]	109.00[I]	*Lampsilis*	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Armored snail *Pyrgulopsis pachyta*	FW	Neotaenioglossa Hydrobilidae	179.74[S]	45.92[S]	Gastropoda	freshwater diatoms and detritus		99-26,000	Not likely to adversely affect

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Species	**Saltwater *v.* Freshwater Exposure**	**Order**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	**Taxon Represented by EC_A**	**Food Items Analysis[c]**			**Preliminary Screening Toxicity Assessment Results**
		Family				**Items**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	
Arroyo toad (larval) *Bufo microscaphus californicus*	FW	Anura Bufonidae	Qualitative Assessment See App. D	Qualitative Assessment See App. D	Actinopterygii	algae, detritus and plant matter		70-26,000	Not likely to adversely affect
Ash Meadows Amargosa pupfish *Cyprinodon nevadensis mionectes*	FW	Antheriniformes (Cyprinodonti-formes) Cyprinodontidae	61.52[I]	13.21[I]	*Cyprinodon*	freshwater insects freshwater invertebrates	192-1,100 42-335,000	49-272 16-29	Not likely to adversely affect
Ash Meadows speckled dace *Rhinichthys osculus nevadensis*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater insects and dipterans; plant matter	192-1,100	49-272 99-26,000	Not likely to adversely affect
Atlantic salmon -NMFS *Salmo salar*	SW (adult) FW (egg and juvenile)	Salmoniformes Salmonidae	39.65[F] (Table 1)	8.51[F] (Table 1)	*Salmo salar*	fw aquatic and terrestrial insects and larvae; fish eggs, marine fishes; marine crustaceans	192-1,100 26-164 2.2-440	49-272 29 43	Not Likely to adversely affect
Banbury springs limpet *Lanx sp.*	FW	Basommatophora Lancidae	108.99[S]	27.84[S]	Basommatophora	freshwater diatoms and detritus		99-26,000	Not likely to adversely affect
Barton Springs salamander *Eurycea sosorum*	FW	Plethodontidae	Qualitative Assessment See App. D	Qualitative Assessment See App. D	Actinopterygii	amphipods small invertebrates	63-400 42-335,000	16 16-29	Not likely to adversely affect
Bayou darter *Etheostoma rubrum*	FW	Perciformes Percidae	18.93[I]	4.06[I]	*Etheostoma*	plant matter; mayfly larvae and other freshwater insects	 192-1,100	99-26,000 49-272	Not screened out
Beautiful shiner *Cyprinella formosa*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	terrestrial and freshwater aquatic insects; algae and plant matter	192-1,100	49-272 70-26,000	Not likely to adversely affect
Big Bend gambusia *Gambusia gaigei*	FW	Antheriformes Poeciliidae	29.28[S]	6.39[S]	Actinopterygii	freshwater insect larvae	192-1,100	49-272	Not likely to adversely affect
Big Spring spinedace *Lepidomeda mollispinis pratensis*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater aquatic insects and larvae; plant matter	192-1,100	49-272 99-26,000	Not likely to adversely affect
Birdwing pearlymussel *Lemiox rimosus* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionididae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Black clubshell *Pleurobema curtum*	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionididae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect

Table 4. Results of the Preliminary Screening Toxicity Assessment for Aquatic Listed Species (all units in µg CN/L) (Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L)									
Species	**Saltwater *v.* Freshwater Exposure**	**Order**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	**Taxon Represented by EC_A**	**Food Items Analysis[c]**			**Preliminary Screening Toxicity Assessment Results**
		Family				**Items**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	
Blackside dace *Phoxinus cumberlandensis*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater algae and detritus; some insects	 192-1,100	70-26,000 49-272	Not likely to adversely affect
Bliss Rapids snail *Taylorconcha serpenticola*	FW	Neotaenioglossa Hydrobidae	179.74[S]	45.92[S]	Gastropoda	freshwater diatoms and detritus		99-26,000	Not likely to adversely affect
Blue shiner *Cyprinella caerulea*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater insects	192-1,100	49-272	Not likely to adversely affect
Bluemask darter *Etheostoma sp.*	FW	Perciformes Percidae	18.93[I]	4.06[I]	*Etheostoma*	freshwater insects crustaceans	192-1,100 42-1,000	49-272 16-29	Not screened out
Bonytail chub *Gila elegans*	FW	Cypriniformes Cyprinidae	30.06[I]	6.45[I]	*Gila elegans*	fw insects and larvae algae	192-1,100	49-272 70-3,000	Not likely to adversely affect
Borax Lake chub *Gila boraxobius*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater diatoms, aquatic inverts, and terrestrial insects	42-335,000	16-29	Not likely to adversely affect
Boulder darter *Etheostoma wapiti*	FW	Perciformes Percidae	18.93[I]	4.06[I]	*Etheostoma*	fw aquatic insects	192-1,100	49-272	Not screened out
Bruneau hot springsnail *Pyrgulopsis bruneauensis*	FW	Neotaenioglossa Hydrobidae	179.74[S]	45.92[S]	Gastropoda	freshwater diatoms and aquatic insects	192-1,100	49-272	Not likely to adversely affect
Bull trout *Salvelinus confluentus*	FW	Salmoniformes Salmonidae	8.62[I]	1.85[I]	*Salvelinus*	freshwater terrestrial and aquatic insects; macrozooplankton mysids fishes	192-1,100 42-28,000 42-335,000 26-900	49-272 11-7,000 16-29 5.6-110	Not screened out
Cahaba shiner *Notropis cahabae*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater crustaceans, insect larvae algae	42-1,000 192-1,100	16-29 49-272 70-3,000	Not likely to adversely affect
California freshwater shrimp *Syncaris pacifica*	FW	Decapoda Atyidae	29.33[S]	8.53[S]	Malacostraca	decomposing plants and detritus		99-26,000	Not likely to adversely affect
California red-legged frog (tadpoles) *Rana aurora draytonii*	FW	Anura Ranidae	Qualitative Assessment See App. D	Qualitative Assessment See App. D	Actinopterygii	algae and detritus; terrestrial and aquatic inverts and small vertebrates	 42-335,000	70-26,000 16-29	Not likely to adversely affect
California tiger salamander (larval)-seasonal pool *Ambystoma californiense*	FW	Caudata Ambystomidae	Qualitative Assessment See App. D	Qualitative Assessment See App. D	Actinopterygii	freshwater aquatic invertebrates and amphibian larvae	42-335,000	16-29	Not likely to adversely affect
Cape Fear shiner *Notropis mekistocholas*	FW	Cypriniformes Cyprinidae	24.68[I]	5.30[I]	*N. mekistocholas*	freshwater plant matter		99-26,000	Not likely to adversely affect

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Species	**Saltwater *v.* Freshwater Exposure**	**Order**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	**Taxon Represented by EC_A**	**Food Items Analysis[c]**			**Preliminary Screening Toxicity Assessment Results**
		Family				**Items**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	
Cherokee darter *Etheostoma scotti*	FW	Perciformes Percidae	18.93[I]	4.06[I]	*Etheostoma*	fw aquatic insects	192-1,100	49-272	Not screened out
Carolina heelsplitter *Lasmigona decorata* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Chihuahua chub *Gila nigrescens*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater aquatic invertebrates; fish fry plant matter	42-335,000 26-900	16-29 5.6-110 99-26,000	Not Likely to adversely affect
Chinook salmon -NMFS *Oncorhynchus tshawytscha*	SW (adult) FW (egg and juvenile)	Salmoniformes Salmonidae	16.26[I]	3.49[I]	*Oncorhynchus tshawytscha*	yolk sacs freshwater plankton freshwater inverts freshwater insects freshwater fish marine fish	nd 42-28,000 42-335,000 192-1,100 26-900 26-160	nd 11-7,000 16-29 49-272 5.6-110 29	Not screened out
Chum salmon -NMFS *Oncorhynchus keta*	SW (adult) FW (egg and juvenile)	Salmoniformes Salmonidae	21.41[I]	4.60[I]	*Oncorhynchus*	yolk sacs freshwater plankton freshwater inverts freshwater insects freshwater fish marine fish	nd 42-28,000 42-335,000 192-1,100 26-900 26-160	nd 11-7,000 16-29 49-272 5.6-110 29	Not screened out
Chipola slabshell *Elliptio chipolaensis* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Clear Creek gambusia *Gambusia heterochir*	FW	Antheriformes Poeciliidae	29.28[S]	6.39[S]	Actinopterygii	freshwater aquatic inverts	42-335,000	16-29	Not likely to adversely affect
Clover Valley speckled dace *Rhinichthys osculus oligoporus*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater insects	192-1,100	49-272	Not likely to adversely affect
Clubshell *Pleurobema clava* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Coho salmon -NMFS *Oncorhynchus kisutch*	SW (adult) FW (egg and juvenile)	Salmoniformes Salmonidae	15.51[I]	3.33[I]	*Oncorhynchus kisutch*	freshwater small invertebrates; aquatic and terrestrial insects and their larvae; small freshwater fishes; marine fishes; marine invertebrates	42-335,000 192-1,100 26-900 26-160 2.2-4,400	16-29 49-272 5.6-110 29 43	Not screened out

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Species	**Saltwater *v.* Freshwater Exposure**	**Order**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	**Taxon Represented by EC_A**	**Food Items Analysis[c]**			**Preliminary Screening Toxicity Assessment Results**
		Family				**Items**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	
Colorado pikeminnow *Ptychocheilus lucius*	FW	Cypriniformes Cyprinidae	26.07[I]	5.60[I]	*P. lucius*	freshwater fish aquatic invertebrates insect larvae	26-900 42-335,000 192-1,100	5.6-110 16-29 49-272	Not likely to adversely affect
Comal springs dryopid beetle *Stygoparnus comalensis*	FW	Coleoptera Dryopidae	95.24[S]	24.34[S]	Insecta	unknown			Not likely to adversely affect
Comal Springs riffle beetle *Heterelmis comalensis*	FW	Coleoptera Elmidae	95.24[S]	24.34[S]	Insecta	unknown			Not likely to adversely affect
Comanche Springs pupfish *Cyprinodon elegans*	FW	Antheriniformes Cyprinodontidae	61.52[I]	13.21[I]	*Cyprinodon*	freshwater insects; plant matter	192-1,100	49-272 99-26,000	Not likely to adversely affect
Conasauga logperch *Percina jenkinsi*	FW	Perciformes Percidae	20.04[I]	4.30[I]	Percidae	freshwater aquatic invertebrates	42-335,000	16-29	Not screened out
Conservancy fairy shrimp *Branchinecta conservatio*	FW	Anostraca Branchinectidae	43.89[†]	11.21[†]	Arthropoda (Phylum)	freshwater detritus very small invertebrates insect larvae	42-335,000 192-1,100	99-26,000 16-29 49-272	Not likely to adversely affect
Coosa moccasinshell *Medionidus parvulus* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Cui ui *Chasmistes cujus*	FW	Cypriniformes Catostomidae	37.25[S]	7.72[S]	Cypriniformes	freshwater bottom-dwelling inverts; algae and detritus	42-335,000	16-29 70-26,000	Not likely to adversely affect
Cumberland elktoe *Alasmidonta atropurpurea* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Cumberland monkeyface *Quadrula intermedia* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Cumberlandian combshell *Epioblasma brevidens* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Cylindrical lioplax *Lioplax cyclostomaformis*	FW	Architaenio Viviparidae	179.74[S]	45.92[S]	Gastropoda	freshwater filter feeder of algae and detritus		70-26,000	Not likely to adversely affect
Dark pigtoe *Pleurobema furvum* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Delta smelt *Hypomesus transpacificus*	SW	Cypriniformes Osmeridae	37.25[S]	7.72[S]	Cypriniformes	fresh copepods marine copepods amphipods opossum shrimp	74-76 63-400 42-1,000 2.2-440	19 16 16-29 43	Not likely to adversely affect

Table 4. Results of the Preliminary Screening Toxicity Assessment for Aquatic Listed Species (all units in µg CN/L) (Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L)									
Species	**Saltwater *v.* Freshwater Exposure**	**Order**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	**Taxon Represented by EC_A**	**Food Items Analysis[c]**			**Preliminary Screening Toxicity Assessment Results**
		Family				**Items**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	
Desert dace *Eremichthys acros*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater algae and diatoms; snails insects	 190-335,000 192-1,100	70-3,000 49-85,000 49-272	Not likely to adversely affect
Desert pupfish *Cyprinodon macularius*	FW	Antheriniformes Cyprinodontidae	61.52[I]	13.21[I]	*Cyprinodon*	freshwater insect plant matter	192-1,100	49-272 99-26,000	Not likely to adversely affect
Devils Hole pupfish *Cyprinodon diabolis*	FW	Antheriniformes Cyprinodontidae	61.52[I]	13.21[I]	*Cyprinodon*	freshwater algae		70-26,000	Not likely to adversely affect
Devils River minnow *Dionda diaboli*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater algae		70-26,000	Not likely to adversely affect
Dromedary pearly mussel *Dromus dromas* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Duskytail darter *Etheostoma percnurum*	FW	Perciformes Percidae	18.93[I]	4.06[I]	*Etheostoma*	microcrustaceans; freshwater insects (chironomid larvae and heptageniid nymphs)	42-1,000 192-1,100	16-29 49-272	Not screened out
Dwarf wedge mussel *Alasmidonta heterodon* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Etowah darter *Etheostoma etowahae*	FW	Perciformes Percidae	18.93[I]	4.06[I]	*Etheostoma*	freshwater aquatic insects	192-1,100	49-272	Not screened out
Fanshell *Cyprogenia stegaria* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Fat three-ridge *Amblema neislerii* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Finerayed pigtoe *Fusconaia cuneolus* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Flat pebblesnail *Lepyrium showalteri*	FW	Neotaenioglossa Hydrobilidae	179.74[S]	45.92[S]	Gastropoda	freshwater diatoms and detritus		99-26,000	Not likely to adversely affect
Flat pigtoe *Pleurobema marshalli* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Foskett speckled dace *Rhinichthys osculus ssp.*	FW	Cypriniformes Cyrpinidae	47.04[I]	10.10[I]	Cyrpinidae	freshwater detritus; insects; eggs of other fishes	 192-1,100 26-900	99-26,000 49-272 5.6-110	Not likely to adversely affect
Fountain darter *Etheostoma fonticola*	FW	Perciformes Percidae	11.33[I]	2.43[I]	*E. fonticola*	freshwater insect larvae crustaceans	192-1,100 42-1,000	49-272 16-29	Not screened out

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Species	**Saltwater *v.* Freshwater Exposure**	**Order**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	**Taxon Represented by EC_A**	**Food Items Analysis[c]**			**Preliminary Screening Toxicity Assessment Results**
		Family				**Items**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	
Gila topminnow *Poeciliopsis occidentalis occidentalis*	FW	Atheriniformes Poeciliidae	29.28[S]	6.39[S]	Actinopterygii	plant matter; crustaceans; aquatic insect larvae, especially mosquitoes	 42-1,000 192-1,100	99-26,000 16-29 49-272	Not likely to adversely affect
Gila trout *Oncorhynchus gilae*	FW	Salmoniformes Salmonidae	21.41[I]	4.60[I]	*Oncorhynchus*	freshwater crustaceans insect larvae fish	42-1,000 192-1,100 26-900	16-29 49-272 5.6-110	Not screened out
Goldline darter *Percina aurolineata*	FW	Perciformes Percidae	20.04[I]	4.30[I]	Percidae	freshwater aquatic insect larvae mostly chironomids	192-1,100	49-272	Not screened out
Greenback cutthroat trout *Oncorhynchus clarki stomias*	FW	Salmoniformes Salmonidae	15.40[I]	3.31[I]	*Oncorhynchus clarki stomias*	yolk sac; freshwater aquatic insects	192-1,100	49-272	Not screened out
Greenblossom *Epioblasma torulosa gubernaculum* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Gulf moccasinshell *Medionidus penicillatus* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Gulf sturgeon *Acipenser oxyrinchus desotoi*	SW	Acipenseriformes Acipenseridae	29.28[S]	6.39[S]	Actinopterygii	marine crustaceans; freshwater crustaceans; insects; clams and mussels; snails; aquatic plant matter	2.2-440 42-1,000 192-1,100 4.7-4,400 190-335,000	43 16-29 49-272 4.4-4,200 49-85,000 11-26,000	Not likely to adversely affect
Hay's Spring amphipod *Stygobromus hayi*	FW	Amphipoda Crangonyctidae	29.33[S]	8.53[S]	Malacostraca	organic matter		99-26,000	Not likely to adversely affect
Heavy pigtoe *Pleurobema taitianum* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Higgins Eye *Lampsilis higginsii* (adult)	FW	Unionoida Unionidae	426.62[I]	109.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Hiko White River springfish *Crenichthys baileyi grandis*	FW	Antheriniformes Goodeidae	29.28[S]	6.39[S]	Actinopterygii	freshwater insects crustaceans algae	192-1,100 42-1,000	49-272 16-29 70-3,000	Not likely to adversely affect
Hine's emerald dragonfly (Larvae) *Somatochlora hineana*	FW	Odonata Corduliidae	95.24[S]	24.34[S]	Insecta	detritus and algae; invertebrates and adult Diptera	42-335,000	70-26,000 16-29	Not likely to adversely affect

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Species	Saltwater *v.* Freshwater Exposure	Order / Family	Acute EC_A[a] (µg/L)	Chronic EC_A[b] (µg/L)	Taxon Represented by EC_A	Food Items Analysis[c]			Preliminary Screening Toxicity Assessment Results
						Items	Acute EC_A[a] (µg/L)	Chronic EC_A[b] (µg/L)	
Houston toad (larval) *Bufo houstonensis*	FW	Anura Bufonidae	Qualitative Assessment See App. D	Qualitative Assessment See App. D	Actinopterygii	phytoplankton zoo-plankton	42-28,000	70-3,000 11-7,000	Not likely to adversely affect
Humpback chub *Gila cypha*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater inverts insects plant matter	42-335,000 192-1,100	16-29 49-272 99-26,000	Not likely to adversely affect
Hungerford's crawling water beetle (larvae) *Brychius hungerfordi*	FW	Coleoptera Haliplidae	95.24[S]	24.34[S]	Insecta	detritus and freshwater algae		70-26,000	Not likely to adversely affect
Hutton tui chub *Gila bicolor ssp.*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater snails insects amphipods	190-335,000 192-1,100 63-400	49-85,000 49-272 16	Not likely to adversely affect
Idaho springsnail *Fontelicella idahoensis*	FW	Neotaenioglossa Hydrobidae	179.74[S]	45.92[S]	Gastropoda	freshwater diatoms and detritus		99-26,000	Not likely to adversely affect
Illinois cave amphipod *Gammarus acherondytes*	FW	Amphipoda Cambaridae	15.33[I]	3.92[I]	*Gammarus*	freshwater detritus		99-26,000	Not screened out
Independence Valley speckled dace *Rhinichthys osculus lethoporus*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater insects	192-1,100	49-272	Not likely to adversely affect
James spinymussel *Pleurobema collina* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
June sucker *Chasmistes liorus*	FW	Cypriniformes Catostomidae	37.25[S]	7.72[S]	Cypriniformes	freshwater bottom-dwelling inverts; algae and detritus	42-335,000	16-29 70-26,000	Not likely to adversely affect
Kauai cave amphipod *Spelaeorchestia koloana*	FW	Amphipoda Talitridae	29.33[S]	8.53[S]	Malacostraca	detritus		99-26,000	Not likely to adversely affect
Kendall Warm Springs dace *Rhinichthys osculus thermalis*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater algae and plant matter; amphipods	63-400	70-26,000 16	Not likely to adversely affect
Kentucky cave shrimp *Palaemonias ganteri*	FW	Decapoda Atyidae	29.33[S]	8.53[S]	Malacostraca	freshwater protozoans and aq. insects; fungi and algae	192-1,100	49-272 70-3,000	Not likely to adversely affect

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Species	**Saltwater *v.* Freshwater Exposure**	**Order**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	**Taxon Represented by EC_A**	**Food Items Analysis[c]**			**Preliminary Screening Toxicity Assessment Results**
		Family				**Items**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	
Kootenai River white sturgeon *Acipenser transmontanus*	SW	Acipenseriformes Acipenseridae	29.28[S]	6.39[S]	Actinopterygii	fw aquatic insect larvae; crustaceans molluscs freshwater fish marine fish	192-1,100 42-1,000 42-335,000 26-900 26-160	49-272 16-29 16-29 5.6-110 29	Not likely to adversely affect
Lacy elimia *Elimia crenatella*	FW	Neotaenioglossa Pleuroceridae	179.74[S]	45.92[S]	Gastropoda	freshwater diatoms and detritus		99-26,000	Not likely to adversely affect
Lahontan cutthroat trout *Oncorhynchus clarki henshawi*	FW	Salmoniformes Salmonidae	11.85[I]	2.54[I]	*Oncorhynchus clarki henshawi*	yolk sacs small freshwater inverts crustaceans aquatic insects small fishes	nd 42-335,000 42-1,000 192-1,100 26-900	nd 16-29 16-29 49-272 5.6-110	Not screened out
Lee County cave isopod *Lirceus usdagalun*	FW	Isopoda Cirolanidae	29.33[S]	8.53[S]	Malacostraca	freshwater detritus		99-26,000	Not likely to adversely affect
Leon Springs pupfish *Cyprinodon bovinus*	FW	Antheriniformes Cyprinodontidae	47.32[I]	10.16[I]	*C. bovinus*	freshwater detritus, diatoms, plant matter; inverts	42-335,000	99-26,000 16-29	Not likely to adversely affect
Leopard darter *Percina pantherina*	FW	Perciformes Percidae	20.04[I]	4.30[I]	Percidae	freshwater algae aquatic inverts	42-335,000	70-3,000 16-29	Not screened out
Little Colorado spinedace *Lepidomeda vittata*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater aquatic insects and larvae; plant matter	192-1,100	49-272 99-26,000	Not likely to adversely affect
Little Kern golden trout *Oncorhynchus aguabonita whitei*	FW	Salmoniformes Salmonidae	21.41[I]	4.60[I]	*Oncorhynchus*	yolk sacs; freshwater aquatic insects	nd 192-1,100	nd 49-272	Not screened out
Littlewing pearlymussel *Pegias fabula* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Loach minnow *Tiaroga cobitis*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater insects plant matter	192-1,100	49-272 99-26,000	Not likely to adversely affect
Longhorn fairy shrimp *Branchinecta longiantenna*	FW	Anostraca Branchinectidae	43.89[†]	11.21[†]	Arthropoda (Phylum)	freshwater detritus; very small invertebrates and their larvae	42-335,000	99-26,000 16-29	Not likely to adversely affect
Lost River sucker *Deltistes luxatus*	FW	Cypriniformes Catostomidae	37.25[S]	7.72[S]	Cypriniformes	freshwater plant matter and detritus		99-26,000	Not likely to adversely affect

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Species	**Saltwater *v.* Freshwater Exposure**	**Order**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	**Taxon Represented by EC_A**	**Food Items Analysis[c]**			**Preliminary Screening Toxicity Assessment Results**
		Family				**Items**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	
Louisiana pearlshell *Margaritifera hembeli* (adult)	FW	Unionoida Unionidae	58.70[l]	15.00[l]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Madison cave isopod *Antrolana lira*	FW	Isopoda Cirolanidae	29.33[s]	8.53[s]	Malacostraca	detritus		99-26,000	Not likely to adversely affect
Maryland darter *Etheostoma sellare*	FW	Perciformes Percidae	18.93[l]	4.06[l]	*Etheostoma*	freshwater snails aquatic insect larvae plant matter	19-335,000 192-1,100	49-85,000 49-272 99-26,000	Not screened out
Moapa dace *Moapa coriacea*	FW	Cypriniformes Catostomidae	37.25[s]	7.72[s]	Cypriniformes	freshwater insects plant matter	192-1,100	49-272 99-26,000	Not likely to adversely affect
Modoc sucker *Catostomus microps*	FW	Cypriniformes Catostomidae	37.25[s]	7.72[s]	Cypriniformes	freshwater bottom-dwelling inverts; algae and detritus	42-335,000	16-29 70-26,000	Not likely to adversely affect
Mohave tui chub *Gila bicolor mohavensis*	FW	Cypriniformes Cyprinidae	47.04[l]	10.10[l]	Cyprinidae	freshwater plankton insect larvae detritus	42-28,000 192-1,100	11-7,000 49-272 99-26,000	Not likely to adversely affect
Nashville crayfish *Orconectes shoupi*	FW	Decapoda Cambaridae	29.33[s]	8.53[s]	Malacostraca	freshwater plant detritus; fish eggs and animal carrion; aquatic invertebrates	26-900 42-335,000	99-26,000 5.6-110 16-29	Not likely to adversely affect
Neosho madtom *Noturus placidus*	FW	Siluritormes Ictaluridae	87.56[l]	18.81[l]	Ictaluridae	freshwater aquatic insects	192-1,100	49-272	Not likely to adversely affect
Newcomb's snail *Erinna newcombi*	FW	Basommatophora Lymnaeidae	108.99[s]	27.84[s]	Basommatophora	freshwater diatoms		70-3,000	Not likely to adversely affect
Niangua darter *Etheostoma nianguae*	FW	Perciformes Percidae	18.93[l]	4.06[l]	*Etheostoma*	freshwater aquatic insects	192-1,100	49-272	Not screened out
Northern riffleshell mussel *Epioblasma torulosa rangiana* (adult)	FW	Unionoida Unionidae	58.70[l]	15.00[l]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Okaloosa darter *Etheostoma okaloosae*	FW	Perciformes Percidae	18.93[l]	4.06[l]	*Etheostoma*	fw aquatic insects; plant matter	192-1,100	49-272 99-26,000	Not screened out
Orangefoot pimpleback *Plethobasus cooperianus* (adult)	FW	Unionoida Unionidae	58.70[l]	15.00[l]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect

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Species	**Saltwater *v.* Freshwater Exposure**	**Order**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	**Taxon Represented by EC_A**	**Food Items Analysis[c]**			**Preliminary Screening Toxicity Assessment Results**
		Family				**Items**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	
Oregon chub *Oregonichthys crameri*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater copepods cladocerans chironomid larvae	74-76 42-28,000 192-1,100	19 11-7,000 49-272	Not likely to adversely affect
Ouachita rock-pocketbook *Arkansia wheeleri* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Ovate clubshell *Pleurobema perovatum* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Owens pupfish *Cyprinodon radiosus*	FW	Cypriniformes Cyprinidae	61.52[I]	13.21[I]	*Cyprinodon*	freshwater algae insects crustaceans plankton	 192-1,100 42-1,000 42-28,00	70-3,000 49-272 16-29 11-7,000	Not likely to adversely affect
Owens tui chub *Gila bicolor snyderi*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	fw aquatic insects	192-1,100	49-272	Not likely to adversely affect
Oyster mussel* *Epioblasma capsaeformis* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Ozark cavefish *Amblyopsis rosae*	FW	Percopsiformes Amblyopsidae	29.28[S]	6.39[S]	Actinopterygii	fw phytoplankton zooplankton small inverts	 42-28,000 42-335,000	70-3,000 11-7,000 16-29	Not likely to adversely affect
Pahranagat roundtail chub *Gila robusta jordani*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	primary plant matter and detritus; freshwater insects	 192-1,100	99-26,000 49-272	Not likely to adversely affect
Pahrump poolfish *Empetrichthys latos*	FW	Antheriniformes Goodenidae	29.28[S]	6.39[S]	Actinopterygii	freshwater algae insects crustaceans plankton	 192-1,100 42-1,000 42-28,000	70-3,000 49-272 16-29 11-7,000	Not likely to adversely affect
Painted rocksnail *Leptoxis taeniata*	FW	Neotainioglossa Pleuroceridae	179.74[S]	45.92[S]	Gastropoda	detritus, diatoms and plant matter		99-26,000	Not likely to adversely affect
Paiute cutthroat trout *Oncorhynchus clarki seleniris*	FW	Salmoniformes Salmonidae	21.41[I]	4.60[I]	*Oncorhynchus*	yolk sacs small freshwater inverts crustaceans aquatic insects	nd 42-335,000 42-1,000 192-1,100	nd 16-29 16-29 49-272	Not screened out
Pale lilliput *Toxolasma cylindrellus*	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect

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Species	Saltwater *v.* Freshwater Exposure	Order	Acute EC_A[a] (µg/L)	Chronic EC_A[b] (µg/L)	Taxon Represented by EC_A	Food Items Analysis[c]			Preliminary Screening Toxicity Assessment Results
		Family				Items	Acute EC_A[a] (µg/L)	Chronic EC_A[b] (µg/L)	
Palezone shiner *Notropis albizonatus*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater insects algae	192-1,100	49-272 70-3,000	Not likely to adversely affect
Pallid sturgeon *Scaphirhynchus albus*	FW	Acipenseriformes Acipenseridae	29.28[S]	6.39[S]	Actinopterygii	freshwater crustaceans worms insect larvae fish	42-1,000 1,100-70,000 192-1,100 26-900	16-29 270-18,000 49-272 5.6-110	Not likely to adversely affect
Peck's cave amphipod *Stygobromus pecki*	FW	Amphipoda Crangonyctidae	29.33[S]	8.53[S]	Malacostraca	organic matter		99-26,000	Not likely to adversely affect
Pecos bluntnose shiner *Notropis simus pecosensis*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater insects algae and plant matter	192-1,100	49-272 70-26,000	Not likely to adversely affect
Pecos gambusia *Gambusia nobilis*	FW	Antheriformes Poeciliidae	29.28[S]	6.39[S]	Actinopterygii	freshwater insects small inverts	192-1,100 42-335,000	49-272 16-29	Not likely to adversely affect
Pink mucket *Lampsili abrupta* (adult)	FW	Unionoida Unionidae	426.62[I]	109.00[I]	*Lampsilis*	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Plicate rocksnail *Leptoxis plicata*	FW	Neotainioglossa Pleuroceridae	179.74[S]	45.92[S]	Gastropoda	freshwater diatoms and detritus		99-26,000	Not likely to adversely affect
Purple bankclimber *Elliptoideus sloatianus* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Purple bean *Villosa perpurpurea*	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Pygmy madtom *Noturus stanauli*	FW	Siluriformes Ictaluridae	87.58[I]	18.80[I]	Ictaluridae	freshwater aquatic insect larvae	192-1,100	49-272	Not likely to adversely affect
Pygmy sculpin *Cottus paulus*	FW	Scorpaeniformes Cottidae	29.28[S]	6.39[S]	Actinopterygii	fw aquatic insects crustaceans isopods	192-1,100 42-1,000 42-335,000	49-272 16-29 16-29	Not likely to adversely affect
Railroad Valley springfish *Crenichthys nevadae*	FW	Antheriniformes Goodeidae	29.28[S]	6.39[S]	Actinopterygii	freshwater insects plant matter	192-1,100	49-272 99-26,000	Not likely to adversely affect
Razorback sucker *Xyrauchen texanus*	FW	Cypriniformes Castostomidae	39.85[I]	8.55[I]	*X. texanus*	fw algae and detritus plankton aquatic insects	 42-28,000 192-1,100	70-3,000 11-7,000 49-272	Not likely to adversely affect
Relict darter *Etheostoma chienense*	FW	Perciformes Percidae	18.93[I]	4.06[I]	*Etheostoma*	freshwater insects crustaceans	192-1,100 42-1,000	49-272 16-29	Not screened out
Ring pink mussel *Obovaria retusa* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect

Table 4. Results of the Preliminary Screening Toxicity Assessment for Aquatic Listed Species (all units in µg CN/L) (Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L)									
Species	Saltwater *v.* Freshwater Exposure	Order / Family	Acute EC_A[a] (µg/L)	Chronic EC_A[b] (µg/L)	Taxon Represented by EC_A	Food Items Analysis[c]			Preliminary Screening Toxicity Assessment Results
						Items	Acute EC_A[a] (µg/L)	Chronic EC_A[b] (µg/L)	
Rio Grande silvery minnow *Hybognathus amarus*	FW	Cypriniformes Cyprinidae	47.04[!]	10.10[!]	Cyprinidae	freshwater diatoms, algae, plant material; larval insect skins	192-1,100	70-26,000 49-272	Not likely to adversely affect
Riverside fairy shrimp *Streptocephalus woottoni*	FW	Anostraca Streptocephalidae	43.89[†]	11.21[†]	Arthropoda (Phylum)	freshwater algae; plankton; small crustaceans	 42-28,000 42-1,000	70-3,000 11-7,000 16-29	Not likely to adversely affect
Roanoke logperch *Percina rex*	FW	Perciformes Percidae	20.04[!]	4.30[!]	Percidae	fw aquatic insect larvae	192-1,100	49-272	Not screened out
Rough pigtoe *Pleurobema plenum* (adult)	FW	Unionoida Unionidae	58.70[!]	15.00[!]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Rough rabbitsfoot *Quadrula cylindrica strigillata* (adult)	FW	Unionoida Unionidae	58.70[!]	15.00[!]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Round rocksnail *Leptoxis ampla*	FW	Neotaenioglossa Pleuroceridae	179.74[s]	45.92[s]	Gastropoda	freshwater diatoms and detritus		99-26,000	Not likely to adversely affect
Royal snail (Marstonia) *Pyrgulopsis ogmoraphe*	FW	Neotainioglossa Hydrobilidae	179.74[s]	45.92[s]	Gastropoda	freshwater diatoms and detritus		99-26,000	Not likely to adversely affect
Sacramento splittail *Pogonichthys macrolepidotus*	FW	Cypriniformes Cyprinidae	47.04[!]	10.10[!]	Cyprinidae	fw opossum shrimp; worms; clams; insect larvae; detritus	42-1,000 1,100-70,000 42-335,000 192-1,100	16-29 270-18,000 16-29 49-272 99-26,000	Not likely to adversely affect
Sam Marcos gambusia/San Marcos gambusia *Gambusia georgei*	FW	Antheriformes Poeciliidae	29.28[s]	6.39[s]	Actinopterygii	freshwater insect larvae inverts	192-1,100 42-335,000	49-272 16-29	Not likely to adversely affect
San Diego fairy shrimp *Branchinecta sandiegoensis*	FW	Anostraca Branchinectidae	43.89[†]	11.21[†]	Arthropoda (Phylum)	freshwater detritus; very small invertebrates and their larvae	 42-335,000	99-26,000 16-29	Not likely to adversely affect
San Marcos salamander *Eurycea nana*	FW	Caudata Plethodontidae	Qualitative Assessment See App. D	Qualitative Assessment See App. D	Actinopterygii	Amphipods midge fly larvae aquatic snails	63-400 1,066 19-335,000	16 272 49-85,000	Not likely to adversely affect
Santa Ana sucker *Catostomus santaanae*	FW	Cypriniformes Catostomidae	37.25[s]	7.72[s]	Cypriniformes	freshwater algae, diatoms, detritus; aquatic insects	192-1,100	70-26,000 49-272	Not likely to adversely affect

Table 4. Results of the Preliminary Screening Toxicity Assessment for Aquatic Listed Species (all units in µg CN/L)
(Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L)

Species	Saltwater *v.* Freshwater Exposure	Order Family	Acute EC_A[a] (µg/L)	Chronic EC_A[b] (µg/L)	Taxon Represented by EC_A	Food Items Analysis[c] Items	Acute EC_A[a] (µg/L)	Chronic EC_A[b] (µg/L)	Preliminary Screening Toxicity Assessment Results
Santa Cruz long-toed salamander (larval) *Ambystoma macrodactylum croceum*	FW	Caudata Ambystomidae	Qualitative Assessment See App. D	Qualitative Assessment See App. D	Actinopterygii	phyto zoo-plankton	42-28,000	70-3,000 11-7,000	Not likely to adversely affect
Scioto madtom *Noturus trautmani*	FW	Siluriformes Ictaluridae	87.58[I]	18.80[I]	Ictaluridae	plant and animal detritus		99-26,000	Not likely to adversely affect
Shasta crayfish *Pacifastacus fortis*	FW	Decapoda Cambaridae	29.33[S]	8.53[S]	Malacostraca	detritus aquatic inverts fish carrion	42-335,000 26-900	99-26,000 16-29 5.6-110	Not likely to adversely affect
Shiny pigtoe *Fusconaia cor* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Shinyrayed pocketbook *Lampsilis subangulata* (adult)	FW	Unionoida Unionidae	426.62[I]	109.00[I]	*Lampsilis*	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Shortnose sturgeon -NMFS *Acipenser brevirostrum*	FW	Acipenseriformes Acipenseridae	11.59[I]	2.49[I]	*A. brevirostrum*	freshwater bottom-dwelling inverts; crustaceans; algae and detritus	42-335,000 42-1,000	16-29 16-29 70-26,000	Not screened out
Shortnose sucker *Chasmistes brevirostris*	FW	Cypriniformes Catostomidae	37.25[S]	7.72[S]	Cypriniformes	freshwater bottom-dwelling inverts; algae and detritus	42-335,000	16-29 70-26,000	Not likely to adversely affect
Slackwater darter *Etheostoma boschungi*	FW	Perciformes Percidae	18.92[I]	4.06[I]	*Etheostoma*	freshwater insects plant matter	192-1,100	49-272 99-26,000	Not screened out
Slender campeloma *Campeloma decampi*	FW	Architaenio Viviparidae	179.74[S]	45.92[S]	Gastropoda	freshwater filter feeder of algae and detritus		70-26,000	Not likely to adversely affect
Slender chub *Erimystax cahni*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater insect larvae mollusks snails	192-1,100 42-335,000 19-335,000	49-272 16-29 49-85,000	Not likely to adversely affect
Smalltooth Sawfish - NMFS *Pristis pectinata*	SW	Rajiformes Pristidae	29.28[†]	6.39[†]	Chordata (Phylum)	unknown			Not likely to adversely affect
Smoky madtom *Noturus baileyi*	FW	Siluriformes Ictaluridae	87.58[I]	18.80[I]	Ictaluridae	fw aquatic insects	192-1,100	49-272	Not likely to adversely affect
Snail darter *Percina tanasi*	FW	Perciformes Percidae	20.04[I]	4.31[I]	Percidae	freshwater snails aquatic inverts	19-335,000 42-335,000	49-85,000 16-29	Not screened out

Table 4. Results of the Preliminary Screening Toxicity Assessment for Aquatic Listed Species (all units in µg CN/L) (Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L)									
Species	**Saltwater *v.* Freshwater Exposure**	**Order**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	**Taxon Represented by EC_A**	**Food Items Analysis[c]**			**Preliminary Screening Toxicity Assessment Results**
		Family				**Items**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	
Snake river physa *Physa natricina*	FW	Basommatophora Physidae	108.99[S]	27.84[S]	Basommatophora	freshwater diatoms and detritus		99-26,000	Not likely to adversely affect
Sockeye salmon -NMFS *Oncorhynchus nerka*	SW (adult) FW (egg and juvenile)	Salmoniformes Salmonidae	21.41[I]	4.60[I]	*Oncorhynchus*	yolk sacs freshwater plankton aquatic inverts insects marine fish	nd 42-28,000 42-335,000 192-1,100 26-160	nd 11-7,000 16-29 49-272 29	Not screened out
Socorro isopod *Thermosphaeroma thermophilus*	FW	Isopoda Sphaeromatidae	29.33[S]	8.53[S]	Malacostraca	freshwater diatoms, algae, detritus		70-26,000	Not likely to adversely affect
Socorro springsnail *Pyrgulopsis neomexicana*	FW	Neotaenioglossa Hydrobilidae	179.74[S]	45.92[S]	Gastropoda	freshwater algae and detritus		70-26,000	Not likely to adversely affect
Sonora chub *Gila ditaenia*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater inverts insects plant matter	42-335,000 192-1,100	16-29 49-272 99-26,000	Not likely to adversely affect
Sonoran tiger salamander (larval) *Ambystoma tigrinum stebbinsi*	FW	Caudata Ambystomidae	Qualitative Assessment See App. D	Qualitative Assessment See App. D	Actinopterygii	freshwater aquatic invertebrates and amphibian larvae	42-335,000	16-29	Not likely to adversely affect
Southern acornshell *Epioblasma othcaloogensis* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Southern combshell *Epioblasma penita* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Southern clubshell *Pleurobema decisum* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Southern pigtoe *Pleurobema georgianum* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Speckled pocketbook *Lampsilis streckeri* (adult)	FW	Unionoida Unionidae	426.62[I]	109.00[I]	*Lampsilis*	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Spinedace *Meda fulgida*	FW	Cypriniformes Cyrpinidae	47.04[I]	10.10[I]	Cyrpinidae	fw insect larvae plant matter	192-1,100	49-272 99-26,000	Not likely to adversely affect
Spotfin chub *Cyprinella monacha*	FW	Cypriniformes Cyprinidae	42.43[I]	9.11[I]	C. *monacha*	fw aquatic insect larvae	192-1,100	49-272	Not likely to adversely affect

Table 4. Results of the Preliminary Screening Toxicity Assessment for Aquatic Listed Species (all units in µg CN/L) (Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L)									
Species	**Saltwater *v.* Freshwater Exposure**	**Order**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	**Taxon Represented by EC_A**	**Food Items Analysis[c]**			**Preliminary Screening Toxicity Assessment Results**
		Family				**Items**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	
Squirrel chimney cave shrimp *Palaemonetes cummingi*	FW	Decapoda Palaemonidae	29.33[S]	8.53[S]	Malacostraca	freshwater algae and plant matter; aquatic insects	 192-1,100	70-26,000 49-272	Not likely to adversely affect
Steelhead trout -NMFS *Oncorhynchus mykiss*	SW	Salmoniformes Salmonidae	26.08[F] (Table 1)	9.80[F] (Table 1)	Oncorhynchus mykiss	yolk sacks inverts aquatic insects amphipods worms fish eggs and small fish plankton aquatic vegetation marine fishes marine crustaceans	nd 42-335,000 192-1,100 63-400 1,100-70,000 26-900 42-28,000 26-160 2.2-440	nd 16-29 49-272 16 270-18,000 5.6-110 11-7,000 99-26,000 29 43	Not likely to adversely affect
Stirrupshell *Quadrula stapes* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Tan riffleshell *Epioblasma florentina walkeri* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Tar River spinymussel *Elliptio steinstansana* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Texas blind salamander *Typhlomolge rathbuni*	FW	Caudata Plethodontidae	Qualitative Assessment See App. D	Qualitative Assessment See App. D	Actinopterygii	aquatic insects invertebrates	192-1,100 42-335,000	49-272 16-29	Not likely to adversely affect
Tidewater goby *Eucyclogobius newberryi*	FW	Perciformes Gobiidae	40.00[S]	8.57[S]	Perciformes	freshwater (low salinity) aquatic inverts	42-335,000	16-29	Not likely to adversely affect
Topeka shiner *Notropis topeka*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	fw midge larvae aquatic invertebrates	192-1,100 42-335,000	49-272 16-29	Not likely to adversely affect
Totoaba - NMFS *Cynoscion macdonaldi*	SW	Perciformes Sciaenidae	40.00[S]	8.57[S]	Perciformes	marine fish invertebrates (shrimp)	26-160 2.2-440	29 43	Not likely to adversely affect
Triangular kidneyshell *Ptychobranchus greeni* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Tubercledblossom *Epioblasma torulosa torulosa* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect

Table 4. Results of the Preliminary Screening Toxicity Assessment for Aquatic Listed Species (all units in µg CN/L) (Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L)									
Species	**Saltwater *v.* Freshwater Exposure**	**Order**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	**Taxon Represented by EC_A**	**Food Items Analysis[c]**			**Preliminary Screening Toxicity Assessment Results**
		Family				**Items**	**Acute EC_A[a] (µg/L)**	**Chronic EC_A[b] (µg/L)**	
Tulotama snail *Tulotoma magnifica*	FW	Architaenio Viviparidae	179.74[s]	45.92[s]	Gastropoda	freshwater filter feeder of algae and detritus		70-26,000	Not likely to adversely affect
Turgidblossom *Epioblasma turgidula* (adult)	FW	Unionoida Unionidae	58.70[l]	15.00[l]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Unarmored threespine stickleback *Gasterosteus aculeatus williamsoni*	FW	Gasterosteiformes Gasterosteidae	29.28[s]	6.39[s]	Actinopterygii	fw aquatic insects snails	192-1,100 190-335,000	49-272 49-85,000	Not likely to adversely affect
Upland combshell *Epioblasma metastriata* (adult)	FW	Unionoida Unionidae	58.70[l]	15.00[l]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Utah valvata snail *Valvata ytahensis*	FW	Architaenio Valvatidae	179.74[s]	45.92[s]	Gastropoda	freshwater diatoms and detritus		99-26,000	Not likely to adversely affect
Vernal pool fairy shrimp *Branchinecta lynchi*	FW	Anostraca Branchinectidae	43.89[†]	11.21[†]	Arthropoda (Phylum)	freshwater detritus; very small invertebrates and their larvae	42-335,000	99-26,000 16-29	Not likely to adversely affect
Vernal pool tadpole shrimp *Lepidurus packardi*	FW	Notostraca Triopsidae	43.89[†]	11.21[†]	Arthropoda (Phylum)	freshwater detritus and plant matter; aquatic insects	192-1,100	99-26,000 49-272	Not likely to adversely affect
Virgin River chub *Gila robusta seminuda*	FW	Cypriniformes Cyprinidae	47.04[l]	10.10[l]	Cyprinidae	fw algae and detritus; aq and terrestrial insects; crustaceans	192-1,100 42-1,000	70-26,000 49-272 16-29	Not likely to adversely affect
Waccamaw silverside *Menidia extensa*	FW	Atheriniformes Atherinidae	29.28[s]	6.39[s]	Actinopterygii	freshwater plankton	42-28,000	11-7,000	Not likely to adversely affect
Warm Springs pupfish *Cyprinodon nevadensis pectoralis*	FW	Antheriniformes Cyprinodontidae	61.52[l]	13.21[l]	*Cyprinodon*	freshwater insects invertebrates plant matter	192-1,100 42-335,000	49-272 16-29 99-26,000	Not likely to adversely affect
Warner sucker *Catostomus warnerensis*	FW	Cypriniformes Catostomidae	37.25[s]	7.72[s]	Cypriniformes	freshwater bottom-dwelling inverts; algae and detritus	42-335,000	16-29 70-26,000	Not likely to adversely affect
Watercress/Snail darter *Etheostoma nuchale*	FW	Perciformes Percidae	18.93[l]	4.06[l]	*Etheostoma*	fw aquatic insects crustaceans snails	192-1,100 42-1,000 190-335,000	49-272 16-29 49-85,000	Not screened out

Table 4. Results of the Preliminary Screening Toxicity Assessment for Aquatic Listed Species (all units in µg CN/L) (Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L)

Species	Saltwater *v.* Freshwater Exposure	Order / Family	Acute EC_A[a] (µg/L)	Chronic EC_A[b] (µg/L)	Taxon Represented by EC_A	Food Items Analysis[c]			Preliminary Screening Toxicity Assessment Results
						Items	Acute EC_A[a] (µg/L)	Chronic EC_A[b] (µg/L)	
White wartyback pearlymussel *Plethobasus cicatricosus* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
White River spinedace *Lepidomeda albivallis*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater insects inverts	192-1,100 42-335,000	49-272 16-29	Not likely to adversely affect
White River springfish *Crenichthys baileyi baileyi*	FW	Antheriniformes Goodeidae	29.58[S]	6.39[S]	Actinopterygii	freshwater insects crustaceans algae	192-1,100 42-1,000	49-272 16-29 70-3,000	Not likely to adversely affect
White catspaw *Epioblasma obliquata perobliqua* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Winged mapleleaf *Quadrula fragosa* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Woundfin *Plagopterus argentissimus*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	fw aquatic insects algae, detritus and seeds	192-1,100	49-272 70-26,000	Not likely to adversely affect
Wyoming toad *Bufo hemiophrys baxteri* (larval)	FW	Anura Bufonidae	Qualitative Assessment See App. D	Qualitative Assessment See App. D	Actinopterygii	aquatic plant matter		99-26,000	Not likely to adversely affect
Yaqui catfish *Ictalurus pricei*	FW	Siluriformes Ictaluridae	87.58[I]	18.80[I]	Ictaluridae	fw insect larvae crustaceans plant matter and detritus	192-1,100 42-1,000	49-272 16-29 99-26,000	Not likely to adversely affect
Yaqui chub *Gila purpurea*	FW	Cypriniformes Cyprinidae	47.04[I]	10.10[I]	Cyprinidae	freshwater insects plant matter and detritus	192-1,100	49-272 99-26,000	Not likely to adversely affect
Yaqui topminnow *Poeciliopsis occidentalis sonoriensis*	FW	Atheriniformes Poeciliidae	29.28[S]	6.39[S]	Actinopterygii	plant matter; crustaceans; aquatic insect larvae, especially mosquitoes	42-1,000 192-1,100	99-26,000 16-29 49-272	Not likely to adversely affect
Yellow-blossom *Epioblasma florentina florentina* (adult)	FW	Unionoida Unionidae	58.70[I]	15.00[I]	Unionidae	detritus, diatoms, plant matter		99-26,000	Not likely to adversely affect
Yellowfin madtom *Noturus flavipinnis*	FW	Siluriformes Ictaluridae	87.58[I]	18.80[I]	Ictaluridae	insects, including flying aquatic insects	192-1,100	49-272	Not likely to adversely affect

[a] Acute assessment effects concentration derived using divisor of 2.27.
[b] Chronic assessment effects concentration based on the NOEC.

[c] Ranges of toxicity values for food items are provided in the order the food items appear. Ranges are from text box (Section 5.1 of this document).
[I] Estimate derived from an ICE model (lower bound of the 95% confidence interval) at the species, genus, or family level. All selected models are listed in Appendix A. Value taken from Table 2 or 3.
[F] Data exist for this Federally-listed species. Value taken from Table 1.
[S] Estimate derived from the SSD model (5% percentile). Value taken from Table 2 or 3
[†] While estimates from the SSD model at the phylum level are not recommended, it is our BPJ to use such values in the absence of viable alternatives

N/A indicates that no data are available.

4.4 Toxic Effects on Aquatic-Dependent Species

4.4.1 Overview

This section comprises the assessment of the section 304(a) aquatic life cyanide criteria on aquatic-dependent species, specific to cyanide. The assessment of toxicity on aquatic-dependent listed species addresses effects expected from a diet of aquatic organisms. As with the initial "water-only" analysis on aquatic species, the assessment of risk to aquatic-dependent species is also based on the estimation of the same risk ratio as explained above. The assessment methodology for aquatic-dependent species is described in more detail in Section 3.4 of the *BE Methods Manual*. The results of the preliminary toxicity assessment for aquatic-dependent species is located in Table 5 in this document which corresponds to Table 4.1 in the *BE Methods Manual*.

4.4.2 Determination of Exposure Concentrations for Aquatic-Dependent Species

No laboratory bioconcentration factors (BCFs) or field-measured bioaccumulation factors (BAFs) are available to estimate cyanide exposure to aquatic-dependent species through their diet.

4.4.3 Determination of Effects Concentrations for Aquatic-Dependent Species

Information on the acute and chronic dietary effects of cyanide to potential surrogate species is compiled in Table 5. Data are primarily from Eisler, *et al.* (1999), and supplemented with additional values from the literature review for cyanide.

Table 5. Acute and chronic toxicity of cyanide to potential surrogate species based on wet weight of oral dose.

Species	Chemical	Dose Description, Duration, and Endpoint	Acute Toxicity LD50 (mg/kg body mass)	Chronic Toxicity (mg/kg body mass/day)	Reference
Mallard, *Anas platyrhynchos*	NaCN	Single oral dose (capsule); 24 h LD50	1.4	--	Henny, *et al.* 1984
American kestrel, *Falco sparverius*	NaCN	Single oral dose (capsule); 30 min LD50	2.1	-	Wiemeyer, *et al.* 1986
Black vulture, *Coragyps atratus*	NaCN	Single oral dose (capsule); 30 min LD50	2.5	-	Wiemeyer, *et al.* 1986

Table 5. Acute and chronic toxicity of cyanide to potential surrogate species based on wet weight of oral dose.

Species	Chemical	Dose Description, Duration, and Endpoint	Acute Toxicity LD50 (mg/kg body mass)	Chronic Toxicity (mg/kg body mass/day)	Reference
Eastern screech-owl, *Otus asio*	NaCN	Single oral dose (capsule); 30 min LD50	4.6	-	Wiemeyer, *et al.* 1986
Japanese quail, *Coturnix japonica*	NaCN	Single oral dose (capsule); 30 min LD50	5.0	-	Wiemeyer, *et al.* 1986
European starling, *Sturnus vulgaris*	NaCN	Single oral dose (capsule); 30 min LD50	9.0	-	Wiemeyer, *et al.* 1986
Domestic chicken, *Gallus domesticus*	NaCN	Single oral dose (capsule); 30 min LD50	11.1	-	Wiemeyer, *et al.* 1986
Little brown bat, *Myotis lucifugus*	NaCN	Single oral dose; LD50	4.5	-	Clarke *et al.* 1991
House mouse, *Mus musculus*	NaCN	Single oral dose; LD50	4.6	-	Clarke *et al.* 1991
Swiss Albino mouse *Mus musculus*	KCN	Single oral dose; 24 h LD50	12.5		Bhattacharya *et al.* 2002
Swiss-webster male mouse *Mus musculus*	KCN	Single oral dose; 24 h LD50	8.5		Sheehy & Way 1968
White-footed mouse, *Peromyscus leucopus*	NaCN	Single oral dose; LD50	14.9	-	Clarke *et al.* 1991
Rat, *Rattus norvegicus*	NaCN	Single oral dose; LD50	3.4	-	Clarke & Clark *et al.* 1967
Rat, *Rattus sp.*	KCN	Drinking water; 30 day NOEC-LOEC	-	20 - 40 (in mg/L)	Pristos 1996
Male Wistar Rat, *Rattus sp.*	KCN	Oral dose; 3 mo. NOEC	-	>0.240	Soto-Blanco *et al.* 2002a
Goat, Alpine-Saanen crossbred	KCN	Oral dose 2x daily; 5 mo. LOEC	-	0.479	Soto-Blanco *et al.* 2002b
Cow	NaCN	Minimum lethal dose	approx. 2.2	-	Boyd *et al.* 1938
Sheep	NaCN	Single oral dose; 24 h LD50	3.7		Burrows & Way 1977

Table 5. Acute and chronic toxicity of cyanide to potential surrogate species based on wet weight of oral dose.

Species	Chemical	Dose Description, Duration, and Endpoint	Acute Toxicity LD50 (mg/kg body mass)	Chronic Toxicity (mg/kg body mass/day)	Reference
Coyote, *Canis latrans*	NaCN	Single oral dose LD50	2.2	-	Sterner *et al.* 1979

The minimum acute dietary LD50 value for birds is 1.4 mg/kg body mass and for mammals is 2.2 mg CN/kg body mass. Despite the rapid and often high lethality of large single cyanide oral doses, repeated sublethal doses, especially in diets, are thought to be tolerated for extended periods of time, "perhaps indefinitely" (Eisler, *et al.*1999). The acute oral toxicity of NaCN and KCN are presumed to be essentially the same (Hill and Henry 1996). Chronic dietary effects to mammals may occur between 0.250 to 0.500 mg/kg body mass when administered orally (via gavage) on a daily basis.

4.4.4 Assessment of Toxicity for Aquatic-Dependent Species

Freshwater and saltwater exposure concentrations for cyanide in food organisms are not available because of reasons discussed above. Since it is assumed the BCF is equal to or less than 1.0, the dietary effect concentration value will always be less than the chronic toxicity of the food item. For cyanide chronic criteria, this produces fish tissue exposure concentrations of:

Freshwater =	5.2 µg/L * 1.0 = 0.0052 mg/kg
Saltwater =	1.0 µg/L * 1.0 = 0.0010 mg/kg

These exposure concentrations, in comparison to all acute and chronic oral dose effect concentrations in Table 5 above, are likely below any potential chronic dietary threshold for aquatic-dependent species and therefore, the effects determination for aquatic-dependent species is made primarily on the acute and chronic assessment effects concentration (EC_A) values for food organisms of these species listed in Table 6. This table in this document corresponds to Table 4.2 in the *BE Methods Manual*. In each instance, the food item effect concentration was derived from known toxicity values for suspected food items.

Table 6. Results of the Preliminary Screening Toxicity Assessment for Aquatic-Dependent Species (Concentrations Based on Wet Weight) (Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L)									
Species	**BCF of food organism– Freshwater**[a]	**BCF of food organisms– Saltwater**[a]	**Estimated Residue levels in diet– Freshwater (mg/kg)**[b]	**Estimated Residue levels in diet– Saltwater (mg/kg)**[b]	**Chronic EC (Dietary Effects Concentration) (mg/kg)**	**Food Items Analysis**[d] **(all units in µg CN/L, unless noted otherwise)**			**Preliminary Screening Toxicity Assessment Results**
						Item	**Acute EC_A**[a]	**Chronic EC_A**[b]	
Alabama redbelly turtle *Pseudemys alabamensis*	1	1	0.0052	0.001	NA[c]	freshwater aquatic vegetation		99-26,000	Not likely to adversely affect
Alabama heelsplitter *Potamilus inflatus* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Alabama moccasinshell *Medionidus acutissimus* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Alabama lampmussel *Lampsilis virescens* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Aleutian Canada goose *Branta canadensis leucopareia*	1	1	0.0052	0.001	NA[c]	wetland plants including eelgrass and algae; aquatic insects; crustaceans	 192-1,100 42-1,000	70-26,000 49-272 16-29	Not likely to adversely affect
Amargosa vole *Microtus californicus scirpensis*	1	1	0.0052	0.001	NA[c]	mother's milk; wetland plant leaves, stems, roots, bark and seeds	nd	nd 99-26,000	Not likely to adversely affect
American crocodile *Crocodylus acutus*	1	1	0.0052	0.001	NA[c]	marine fish; fw fish, including largemouth bass, tarpon and mullet	26-160 26-900	29 5.6-110	Not likely to adversely affect
Appalachean elktoe *Alasmidonta raveneliana* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Appalachian monkeyface *Quadrula sparsa* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Arkansas fatmucket *Lampsilis powelli* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Ash Meadows naucorid bug *Ambrysus amargosus*	1	1	0.0052	0.001	NA[c]	aquatic insect larvae	192-1,100	49-272	Not likely to adversely affect
Atlantic salt marsh snake *Nerodia clarkii taeniata*	1	1	0.0052	0.001	NA[c]	small marine fish	26-160	29	Not likely to adversely affect
Bald eagle *Haliaeetus leucocephalus*	1	1	0.0052	0.001	NA[c]	fish, small mammals, carrion	26-900	5.6-110	Not likely to adversely affect
Birdwing pearlymussel *Lemiox rimosus* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect

Table 6. Results of the Preliminary Screening Toxicity Assessment for Aquatic-Dependent Species (Concentrations Based on Wet Weight) (Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L)									
Species	BCF of food organism–Freshwater[a]	BCF of food organisms–Saltwater[a]	Estimated Residue levels in diet–Freshwater (mg/kg)[b]	Estimated Residue levels in diet–Saltwater (mg/kg)[b]	Chronic EC (Dietary Effects Concentration) (mg/kg)	Food Items Analysis[d] (all units in µg CN/L, unless noted otherwise)			Preliminary Screening Toxicity Assessment Results
						Item	Acute EC_A[a]	Chronic EC_A[b]	
Black clubshell *Pleurobema curtum* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Blue whale -NMFS *Balaenoptera musculus*	1	1	0.0052	0.001	NA[c]	mother's milk krill and marine inverts plankton crustaceans small fish	nd 2.2-4,400 7.5 2.2-440 26-160	nd 43 7.1 43 29	Not likely to adversely affect
Bog turtle *Clemmys muhlenbergii*	1	1	0.0052	0.001	NA[c]	freshwater aquatic beetles, lepidopteran larvae, caddisfly larvae; snails; nematodes; fleshy pondweed seeds; carrion	192-1,100 190-335,000 42-335,000 26-900	49-272 49-85,000 16-29 99-26,000 5.6-110	Not likely to adversely affect
Bowhead whale -NMFS *Balaena mysticetus*	1	1	0.0052	0.001	NA[c]	mother's milk marine amphipods copepods and euphausiids	nd 2.2-440 7.5	nd 43 7.1	Not likely to adversely affect
Brown pelican *Pelecanus occidentalis*	1	1	0.0052	0.001	NA[c]	marine fish	26-160	29	Not likely to adversely affect
California least tern *Sterna antillarum browni*	1	1	0.0052	0.001	NA[c]	northern anchovy, topsmelt, surf-perch, killifish, and mosquitofish	26-160	29	Not likely to adversely affect
California clapper rail *Rallus longirostris obsoletus*	1	1	0.0052	0.001	NA[c]	marine mussels and clams	4.7-4,400	4.4-4,200	Not likely to adversely affect
California red-legged frog (adults) *Rana aurora draytonii*	1	1	0.0052	0.001	NA[c]	algae and detritus; terrestrial and aquatic inverts; small vertebrates	 42-335,000 26-900	70-26,000 16-29 5.6-110	Not likely to adversely affect
Caribbean monk seal -NMFS *Monachus tropicalus*	1	1	0.0052	0.001	NA[c]	mother's milk; spiny lobsters; octopi, squid, marine fishes	nd 2.2-440 26-160	nd 43 29	Not likely to adversely affect
Carolina heelsplitter *Lasmigona decorata* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
catspaw *Epioblasma obliquata obliquata* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect

Table 6. Results of the Preliminary Screening Toxicity Assessment for Aquatic-Dependent Species (Concentrations Based on Wet Weight) (Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L)									
Species	**BCF of food organism–Freshwater[a]**	**BCF of food organisms–Saltwater[a]**	**Estimated Residue levels in diet–Freshwater (mg/kg)[b]**	**Estimated Residue levels in diet–Saltwater (mg/kg)[b]**	**Chronic EC (Dietary Effects Concentration) (mg/kg)**	**Food Items Analysis[d] (all units in µg CN/L, unless noted otherwise)**			**Preliminary Screening Toxicity Assessment Results**
						Item	**Acute EC_A[a]**	**Chronic EC_A[b]**	
Cave crayfish *Cambarus aculabrum*	1	1	0.0052	0.001	NA[c]	probably freshwater plant matter		99-26,000	Not likely to adversely affect
Chipola slabshell *Elliptio chipolaensis* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Chittenago ovate amber snail *Succinea chittenagoensis*	1	1	0.0052	0.001	NA[c]	microscopic terrestrial plants		99-26,000	Not likely to adversely affect
Clubshell *Pleurobema clava* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Concho water snake *Nerodia paucimaculata*	1	1	0.0052	0.001	NA[c]	freshwater minnows and amphibians; crustacean	26-900 42-1,000	5.6-110 16-29	Not likely to adversely affect
Coosa moccasinshell *Medionidus parvulus* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Cracking pearlymussel *Hemistena lata* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Cumberland bean *Villosa trabalis* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Cumberland monkeyface *Quadrula intermedia* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Cumberland elktoe *Alasmidonta atropurpurea* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Cumberland pigtoe *Pleurobema gibberum* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Cumberlandian combshell *Epioblasma brevidens* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Curtis' pearlymussel *Epioblasma florentina curtisii* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Dark pigtoe *Pleurobema furvum* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Delta green ground beetle *Elaphrus viridis*	1	1	0.0052	0.001	NA[c]	springtails, insect larvae	192-1,100	49-272	Not likely to adversely affect
Desert slender salamander (adult) *Batrachoseps aridus*	1	1	0.0052	0.001	NA[c]	larval and adult flies, ants, spiders, sowbugs; snails	192-1,100 190-335,000	49-272 49-85,000	Not likely to adversely affect

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Species	BCF of food organism–Freshwater[a]	BCF of food organisms–Saltwater[a]	Estimated Residue levels in diet–Freshwater (mg/kg)[b]	Estimated Residue levels in diet–Saltwater (mg/kg)[b]	Chronic EC (Dietary Effects Concentration) (mg/kg)	Food Items Analysis[d] (all units in µg CN/L, unless noted otherwise)			Preliminary Screening Toxicity Assessment Results
						Item	Acute EC_A[a]	Chronic EC_A[b]	
Dromedary pearly mussel *Dromus dromas* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Dwarf wedge mussel *Alasmidonta heterodon* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Eskimo curlew *Numenius borealis*	1	1	0.0052	0.001	NA[c]	fw aquatic insects; estuarine aquatic insects; snails; wetland berries	192-1,100 2.2-4,000 190-335,000 nd	49-272 43 49-85,000 nd	Not likely to adversely affect
Fanshell *Cyprogenia stegaria* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Fat pocketbook *Potamilus capax* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Fat three-ridge *Amblema neislerii* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Finback whale -NMFS *Balaenoptera physalus*	1	1	0.0052	0.001	NA[c]	mother's milk herring and capelin crustaceans and krill	nd 26-160 2.2-440	nd 29 43	Not likely to adversely affect
Fine-lined pocketbook *Lampsilis altilis* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Finerayed pigtoe *Fusconaia cuneolus* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Flat pigtoe *Pleurobema marshalli* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Flattened musk turtle *Sternotherus depressus*	1	1	0.0052	0.001	NA[c]	freshwater mussels snails	42-335,000 190-335,000	16-29 49-85,000	Not likely to adversely affect
Florida/Everglades snail kite *Rostrhamus sociabilis plumbeus*	1	1	0.0052	0.001	NA[c]	apple snail	678	173.3	Not likely to adversely affect
Florida panther (adult) *Puma concolor coryi*	1	1	0.0052	0.001	NA[c]	mammals primarily whitetailed deer, feral hogs, opossum, raccoons		Likely > 2.4mg/kg[c]	Not likely to adversely affect
Florida salt marsh vole *Microtus pennsylvanicus dukecampbelli*	1	1	5.2	1.0	NA[c]	mother's milk marine wetland plant leaves, stems, roots, and seeds	nd	nd 99-26,000	Not likely to adversely affect

Table 6. Results of the Preliminary Screening Toxicity Assessment for Aquatic-Dependent Species (Concentrations Based on Wet Weight) (Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L)									
Species	**BCF of food organism– Freshwater**[a]	**BCF of food organisms– Saltwater**[a]	**Estimated Residue levels in diet– Freshwater (mg/kg)**[b]	**Estimated Residue levels in diet– Saltwater (mg/kg)**[b]	**Chronic EC (Dietary Effects Concentration) (mg/kg)**	**Food Items Analysis**[d] **(all units in µg CN/L, unless noted otherwise)**			**Preliminary Screening Toxicity Assessment Results**
						Item	**Acute EC_A**[a]	**Chronic EC_A**[b]	
Giant garter snake *Thamnophis gigas*	1	1	0.0052	0.001	NA[c]	freshwater fishes, tadpoles and frogs	26-900	5.6-110	Not likely to adversely affect
Gray Bat *Myotis grisescens* (adults)	1	1	0.0052	0.001	NA[c]	night-flying aquatic insects, mosquitoes	192-1,100	49-272	Not likely to adversely affect
Green sea turtle -NMFS *Chelonia mydas*	1	1	0.0052	0.001	NA[c]	marine aquatic grass and algae		11	Not likely to adversely affect
Greenblossom *Epioblasma torulosa gubernaculum* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Grizzly bear (adults) *Ursus arctos horribilis*	1	1	0.0052	0.001	NA[c]	wetland plants fish and carrion	 26-900	99-26,000 5.6-110	Not likely to adversely affect
Guadalupe fur seal -NMFS *Arctocephalus townsendi*	1	1	0.0052	0.001	NA[c]	mother's milk saltwater small fish mollusks	nd 26-160 4.7-4,400	nd 29 4.4-4,200	Not likely to adversely affect
Gulf moccasinshell *Medionidus penicillatus* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Gulf of California harbor porpoise -NMFS *Phocoena sinus*	1	1	0.0052	0.001	NA[c]	mother's milk marine fish crustaceans	nd 26-160 2.2-440	nd 29 43	Not likely to adversely affect
Hawaiian common moorhen (gallinule) *Gallinula chloropus sandvicensis*	1	1	0.0052	0.001	NA[c]	algae and aquatic plants insects mollusks	 192-1,100 4.7-4,400	70-26,000 49-272 4.4-4,200	Not likely to adversely affect
Hawaiian duck *Anas wyvilliana*	1	1	0.0052	0.001	NA[c]	snails and earthworms; dragonfly larvae; grass, and other wetland plant matter	190-335,000 192-1,100	49-85,000 49-272 99-26,000	Not likely to adversely affect
Hawaiian stilt *Himantopus mexicanus knudseni*	1	1	0.0052	0.001	NA[c]	marine worms and insects crabs small fish	2.2-4,400 2.2-440 26-160	43 43 29	Not likely to adversely affect
Hawaiian monk seal *Monachus schauinslandi*	1	1	0.0052	0.001	NA[c]	mother's milk; spiny lobsters; octopi, squid, marine fishes	nd 2.2-440 26-160	nd 43 29	Not likely to adversely affect
Hawaiian dark-rumped petrel *Pterodroma phaeopgyia sandwichensis*	1	1	0.0052	0.001	NA[c]	marine fish plankton	26-160 7.5	29 7.1	Not likely to adversely affect

Table 6. Results of the Preliminary Screening Toxicity Assessment for Aquatic-Dependent Species (Concentrations Based on Wet Weight) (Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L)									
Species	**BCF of food organism–Freshwater**[a]	**BCF of food organisms–Saltwater**[a]	**Estimated Residue levels in diet–Freshwater (mg/kg)**[b]	**Estimated Residue levels in diet–Saltwater (mg/kg)**[b]	**Chronic EC (Dietary Effects Concentration) (mg/kg)**	**Food Items Analysis**[d] **(all units in µg CN/L, unless noted otherwise)**			**Preliminary Screening Toxicity Assessment Results**
						Item	**Acute EC_A**[a]	**Chronic EC_A**[b]	
Hawaiian coot *Fulica americana alai*	1	1	0.0052	0.001	NA[c]	aquatic plants crustaceans insects	 42-1,000 192-1,100	99-26,000 16-29 49-272	Not likely to adversely affect
Hawaiian hoary bat *Lasiurus cinereus semotus*	1	1	0.0052	0.001	NA[c]	mother's milk terrestrial and freshwater aquatic emergent insects	nd 192-1,100	nd 49-272	Not likely to adversely affect
Hawksbill sea turtle *Eretmochelys imbricata*	1	1	0.0052	0.001	NA[c]	jellyfish, sponges, sessile organisms; algae	2.2-4,400	43 11.0	Not likely to adversely affect
Heavy pigtoe *Pleurobema taitianum* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Higgins Eye *Lampsilis higginsii* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Hine's emerald dragonfly (adults) *Somatochlora hineana*	1	1	0.0052	0.001	NA[c]	invertebrates and adult Diptera	42-335,000	16-29	Not likely to adversely affect
Humpback whale -NMFS *Megaptera novaeangliae*	1	1	0.0052	0.001	NA[c]	mother's milk marine fish crustaceans plankton	nd 26-160 2.2-440 7.5	Nd 29 43 7.1	Not likely to adversely affect
Indiana bat (adult) *Myotis sodalis*	1	1	0.0052	0.001	NA[c]	moths and aquatic insects	192-1,100	49-272	Not likely to adversely affect
James spinymussel *Pleurobema collina* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Kanab ambersnail *Oxyloma haydenai kanabensis*	1	1	0.0052	0.001	NA[c]	freshwater algae growing on wetland plants and soil		70-3,000	Not likely to adversely affect
Kemp's ridley sea turtle -NMFS *Lepidochelys kempii*	1	1	0.0052	0.001	NA[c]	blue crabs and other crustaceans; marine fish	2.2-440 26-160	43 29	Not likely to adversely affect
Lake Erie water snake *Nerodia sipedon insularum*	1	1	0.0052	0.001	NA[c]	freshwater fish and amphibians	26-900	5.6-110	Not likely to adversely affect
Laysan duck *Anas laysanensis*	1	1	0.0052	0.001	NA[c]	marine insects, brine flies, cutworm larvae, miller moths; crustaceans	2.2-4,400 2.2-440	43 43	Not likely to adversely affect

Table 6. Results of the Preliminary Screening Toxicity Assessment for Aquatic-Dependent Species (Concentrations Based on Wet Weight) (Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L)									
Species	BCF of food organism–Freshwater[a]	BCF of food organisms–Saltwater[a]	Estimated Residue levels in diet–Freshwater (mg/kg)[b]	Estimated Residue levels in diet–Saltwater (mg/kg)[b]	Chronic EC (Dietary Effects Concentration) (mg/kg)	Food Items Analysis[d] (all units in µg CN/L, unless noted otherwise)			Preliminary Screening Toxicity Assessment Results
						Item	Acute EC_A[a]	Chronic EC_A[b]	
Least tern *Sterna antillarum*	1	1	0.0052	0.001	NA[c]	fw fish marine fish	26-900 26-160	5.6-110 29	Not likely to adversely affect
Least Bell's vireo *Vireo bellii pusillus*	1	1	0.0052	0.001	NA[c]	terrestrial insects	192-1,100	49-272	Not likely to adversely affect
Leatherback sea turtle -NMFS *Dermochelys coriacea*	1	1	0.0052	0.001	NA[c]	jellyfish and 'soft-bodied' sea animals	2.2-4,400	43	Not likely to adversely affect
Light-footed clapper rail *Rallus longirostris levipes*	1	1	0.0052	0.001	NA[c]	freshwater plant matter snails crustaceans insects tadpoles and small fish	 190-335,000 42-1,000 192-1,100 26-900	99-26,000 49-85,000 16-29 49-272 5.6-110	Not likely to adversely affect
Littlewing pearlymussel *Pegias fabula* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Loggerhead sea turtle -NMFS *Caretta caretta*	1	1	0.0052	0.001	NA[c]	marine mollusks, sponges, horseshoe crabs	4.7-4,400	4.4-4,200	Not likely to adversely affect
Lotis blue butterfly *Lycaeides argyrognomon lotis*	1	1	0.0052	0.001	NA[c]	wetland plant - Lotus formosissimus		99-26,000	Not likely to adversely affect
Louisiana black bear (adult) *Ursus americanus luteolus*	1	1	0.0052	0.001	NA[c]	freshwater plants fish	 26-900	99-26,000 5.6-110	Not likely to adversely affect
Louisiana pearlshell *Margaritifera hembeli* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Marbled murrelet (open ocean foraging) *Brachyramphus marmoratus marmoratus*	1	1	0.0052	0.001	NA[c]	marine fish: northern anchovy, Pacific herring, & Pacific sand lance	26-160	29	Not likely to adversely affect
Mariana common moorhen *Gallinula chloropus guami*	1	1	0.0052	0.001	NA[c]	freshwater aquatic plants mollusks snails insects	 4.7-4,400 190-335,000 192-1,100	99-26,000 4-4,200 49-85,000 49-272	Not likely to adversely affect
Mississippi sandhill crane *Grus canadensis pulla*	1	1	0.0052	0.001	NA[c]	reptiles, amphibians aquatic insects aquatic plant material, seeds	nd 192-1,100	nd 49-272 99-26,000	Not likely to adversely affect
Mitchell's satyr butterfly *Neonympha mitchellii mitchellii*	1	1	0.0052	0.001	NA[c]	wetland plant species-Carex		99-26,000	Not likely to adversely affect
Newell's Townsend shearwater *Puffinus auricularis newelli*	1	1	0.0052	0.001	NA[c]	marine fish plankton	26-160 7.5	29 7.1	Not likely to adversely affect

Table 6. Results of the Preliminary Screening Toxicity Assessment for Aquatic-Dependent Species (Concentrations Based on Wet Weight) (Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L)									
Species	BCF of food organism– Freshwater[a]	BCF of food organisms– Saltwater[a]	Estimated Residue levels in diet– Freshwater (mg/kg)[b]	Estimated Residue levels in diet– Saltwater (mg/kg)[b]	Chronic EC (Dietary Effects Concentration) (mg/kg)	Food Items Analysis[d] (all units in µg CN/L, unless noted otherwise)			Preliminary Screening Toxicity Assessment Results
						Item	Acute EC_A[a]	Chronic EC_A[b]	
Northeastern beach tiger beetle *Cicindela dorsalis dorsalis*	1	1	0.0052	0.001	NA[c]	terrestrial amphipods, flies, beach arthropods, scavenges on dead amphipods; marine fish; crabs	2.2-4,400 26-160 2.2-440	43 29 43	Not likely to adversely affect
Northern Atlantic right whale -NMFS *Eubalaena\Balaena glacialis*	1	1	0.0052	0.001	NA[c]	mother's milk marine plankton invertebrates	nd 7.5 2.2-4,400	nd 7.1 43	Not likely to adversely affect
Northern copperbelly water snake *Nerodia erythrogaster neglecta*	1	1	0.0052	0.001	NA[c]	freshwater frogs, tadpoles, salamanders and fishes; crayfish; invertebrates	26-900 42-1,000 42-335,000	5.6-110 16-29 16-29	Not likely to adversely affect
Northern riffleshell mussel *Epioblasma torulosa rangiana* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Ochlockonee moccasinshell *Medionidus simpsonianus* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Olive ridley sea turtle -NMFS *Lepidochelys olivacea*	1	1	0.0052	0.001	NA[c]	crabs, other marine crustaceans; mollusks	2.2-440 4.7-4,400	43 4.4-4,200	Not likely to adversely affect
Orange-nacre mucket *Lampsilis perovalis* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Orangefoot pimpleback *Plethobasus cooperianus* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Ouachita rock-pocketbook *Arkansia wheeleri* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Oval pigtoe *Pleurobema pyriforme* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Ovate clubshell *Pleurobema perovatum* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Oyster mussel *Epioblasma capsaeformis* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Pale lilliput *Toxolasma cylindrellus* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect

Table 6. Results of the Preliminary Screening Toxicity Assessment for Aquatic-Dependent Species (Concentrations Based on Wet Weight) (Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L)									
Species	BCF of food organism–Freshwater[a]	BCF of food organisms–Saltwater[a]	Estimated Residue levels in diet–Freshwater (mg/kg)[b]	Estimated Residue levels in diet–Saltwater (mg/kg)[b]	Chronic EC (Dietary Effects Concentration) (mg/kg)	Food Items Analysis[d] (all units in µg CN/L, unless noted otherwise)			Preliminary Screening Toxicity Assessment Results
						Item	Acute EC_A[a]	Chronic EC_A[b]	
Pink mucket *Lampsili abrupta* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Piping plover *Charadrius melodus*	1	1	0.0052	0.001	NA[c]	marine crustaceans shellfish insects	2.2-440 4.7-4,400 2.2-4,400	43 4.4-4,200 43	Not likely to adversely affect
Plymouth redbelly turtle *Pseudemys rubriventris bangsi*	1	1	0.0052	0.001	NA[c]	fw aquatic vegetation crayfish small fish	 42-1,000 26-900	99-26,000 16-29 5.6-110	Not likely to adversely affect
Puritan tiger beetle *Cicindela puritana*	1	1	0.0052	0.001	NA[c]	amphipods; scavenging on dead crustaceans and dipterans; fish	62-400 42-335,000 26-900	16 16-29 5.6-110	Not likely to adversely affect
Purple bean *Villosa perpurpurea* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Purple bankclimber *Elliptoideus sloatianus* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Ring pink mussel *Obovaria retusa* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Ringed map/sawback turtle *Graptemys oculifera*	1	1	0.0052	0.001	NA[c]	freshwater mussels snails crustaceans	42-335,000 190-335,000 42-1,000	16-29 49-85,000 16-29	Not likely to adversely affect
Roseate tern *Sterna dougalli dougalli*	1	1	0.0052	0.001	NA[c]	freshwater fish marine fish	26-900 26-160	5.6-110 29	Not likely to adversely affect
Rough pigtoe *Pleurobema plenum* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Rough rabbitsfoot *Quadrula cylindrica strigillata* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Salt marsh harvest mouse *Reithrodontomys raviventris*	1	1	0.0052	0.001	NA[c]	mother's milk wetland plants and seeds	nd	nd 99-26,000	Not likely to adversely affect

Table 6. Results of the Preliminary Screening Toxicity Assessment for Aquatic-Dependent Species (Concentrations Based on Wet Weight) (Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L)									
Species	**BCF of food organism–Freshwater[a]**	**BCF of food organisms–Saltwater[a]**	**Estimated Residue levels in diet–Freshwater (mg/kg)[b]**	**Estimated Residue levels in diet–Saltwater (mg/kg)[b]**	**Chronic EC (Dietary Effects Concentration) (mg/kg)**	**Food Items Analysis[d] (all units in µg CN/L, unless noted otherwise)**			**Preliminary Screening Toxicity Assessment Results**
						Item	**Acute EC_A[a]**	**Chronic EC_A[b]**	
San Francisco garter snake *Thamnophis sirtalis tetrataenia*	1	1	0.0052	0.001	NA[c]	red-legged frogs, Pacific tree frogs, immature California newts, western toads, threespine stickleback, and mosquito fish	26-900	5.6-110	Not likely to adversely affect
Sei whale -NMFS *Balaenoptera borealis*	1	1	0.0052	0.001	NA[c]	mother's milk marine euphausiids and copepods; small fish	nd 7.5 26-160	nd 7.1 29	Not likely to adversely affect
Shiny pigtoe *Fusconaia cor* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Shinyrayed pocketbook *Lampsilis subangulata* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Short-tail albatross *Phoebastria albatrus*	1	1	0.0052	0.001	NA[c]	marine fish	26-160	29	Not likely to adversely affect
Southern acornshell *Epioblasma othcaloogensis* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Southern combshell *Epioblasma penita* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Southern pigtoe *Pleurobema georgianum* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Southern clubshell *Pleurobema decisum* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Southern sea otter *Enhydra lutris nereis*	1	1	0.0052	0.001	NA[c]	mother's milk abalone marine shellfish	nd 2.2-4,400 4.7-4,400	nd 43 4.4-4,200	Not likely to adversely affect
Southwestern willow flycatcher *Empidonax traillii extimus*	1	1	0.0052	0.001	NA[c]	emergent aquatic flying insects including mosquitoes, and other terrestrial flying insects	192-1,100	49-272	Not likely to adversely affect
Speckled pocketbook *Lampsilis streckeri* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect

Table 6. Results of the Preliminary Screening Toxicity Assessment for Aquatic-Dependent Species (Concentrations Based on Wet Weight) (Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L)									
Species	BCF of food organism– Freshwater[a]	BCF of food organisms– Saltwater[a]	Estimated Residue levels in diet– Freshwater (mg/kg)[b]	Estimated Residue levels in diet– Saltwater (mg/kg)[b]	Chronic EC (Dietary Effects Concentration) (mg/kg)	Food Items Analysis[d] (all units in µg CN/L, unless noted otherwise)			Preliminary Screening Toxicity Assessment Results
						Item	Acute EC_A[a]	Chronic EC_A[b]	
Spectacled eider *Somateria fischeri*	1	1	0.0052	0.001	NA[c]	marine mollusks; crustaceans and pelagic amphipods; insects; plant matter	4.7-4,400 2.2-440 2.2-4400	4.4-4,200 43 43 99-26,000	Not likely to adversely affect
Sperm whale -NMFS *Physeter macrocephalus*	1	1	0.0052	0.001	NA[c]	mother's milk squid, sharks, octopi, rays, skates and marine fishes	nd 26-160	nd 29	Not likely to adversely affect
St. Francis' satyr butterfly *Neonympha mitchellii francisci*	1	1	0.0052	0.001	NA[c]	wetland plant species-Carex		99-26,000	Not likely to adversely affect
Stellar sea lion -NMFS *Eumetopias jubatus*	1	1	0.0052	0.001	NA[c]	mother's milk marine fish and squid	nd 26-160	nd 29	Not likely to adversely affect
Steller's eider *Polysticta stelleri*	1	1	0.0052	0.001	NA[c]	marine crustaceans; fw crustaceans; mollusks; polychaete worms; aquatic insect larvae; pondweeds	2.2-440 42-1,000 4.7-4,400 1,100-70,000 192-1,100	43 16-29 4.4-4,200 272-18,000 49-272 99-26,000	Not likely to adversely affect
Stirrupshell *Quadrula stapes* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Tan riffleshell *Epioblasma florentina walkeri* (larvae)	1	1	0.0052	0.001		fish fluids	26-900	5.6-110	Not likely to adversely affect
Tar River spinymussel *Elliptio steinstansanal* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Triangular kidneyshell *Ptychobranchus greeni* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Tubercledblossom *Epioblasma torulosa torulosa* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Turgidblossom *Epioblasma turgidula* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Upland combshell *Epioblasma metastriata* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Virginia big-eared bat *Corynorhinus townsendii virginianus*	1	1	0.0052	0.001	NA[c]	mother's milk moths and some freshwater aquatic emerging insects	nd 192-1,100	nd 49-272	Not likely to adversely affect

Table 6. Results of the Preliminary Screening Toxicity Assessment for Aquatic-Dependent Species (Concentrations Based on Wet Weight) (Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L)									
Species	**BCF of food organism– Freshwater**[a]	**BCF of food organisms– Saltwater**[a]	**Estimated Residue levels in diet– Freshwater (mg/kg)**[b]	**Estimated Residue levels in diet– Saltwater (mg/kg)**[b]	**Chronic EC (Dietary Effects Concentration) (mg/kg)**	**Food Items Analysis**[d] **(all units in µg CN/L, unless noted otherwise)**			**Preliminary Screening Toxicity Assessment Results**
						Item	**Acute EC_A**[a]	**Chronic EC_A**[b]	
West Indian manatee *Trichechus manatus*	1	1	0.0052	0.001	NA[c]	mother's milk aquatic plants	nd	nd 99-26,000	Not likely to adversely affect
Western snowy plover *Charadrius alexandrinus nivosus*	1	1	0.0052	0.001	NA[c]	freshwater inverts marine inverts marine crustaceans shellfish insects	42-335,000 2.2-4,400 42-1,000 2.2-440 192-1,100	16-29 43 16-29 43 49-272	Not likely to adversely affect
White wartyback pearlymussel *Plethobasus cicatricosus* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
White catspaw *Epioblasma obliquata perobliqua* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Whooping crane *Grus americana*	1	1	0.0052	0.001	NA[c]	blue crabs fw aquatic insects invertebrates and clams	4.7-4,400 192-1,100 42-335,000	4.4-4,200 49-272 16-29	Not likely to adversely affect
Winged mapleleaf *Quadrula fragosa* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Wood stork *Mycteria americana*	1	1	0.0052	0.001	NA[c]	freshwater fish (2 to 6" TL) and amphibians; marine fish	26-900 26-160	5.6-110 29	Not likely to adversely affect
Wyoming Toad *Bufo hemiophrys baxteri* (adult)	1	1	0.0052	0.001	NA[c]	aquatic plant matter		99-26,000	Not likely to adversely affect
Yellow-blossom *Epioblasma florentina florentina* (larvae)	1	1	0.0052	0.001	NA[c]	fish fluids	26-900	5.6-110	Not likely to adversely affect
Yellow-blotched map turtle *Graptemys flavimaculata*	1	1	0.0052	0.001	NA[c]	freshwater mussels snails aquatic insect larvae	42-335,000 190-335,000 192-1,100	16-29 49-85,000 49-272	Not likely to adversely affect
Yuma clapper rail *Rallus longirostris yumanensis*	1	1	0.0052	0.001	NA[c]	freshwater fish clams and crayfish insects	26-900 42-335,000 192-1,100	5.6-110 16-29 49-272	Not likely to adversely affect

[a] BCF value of $1 L \cdot kg^{-1}$ is a default value applied in the absence of any actual BCF or BAF values for cyanide (see Section 4.4.2).

[b] Estimated residue value is the product of the default BCF value of $1 L \cdot kg^{-1}$ for cyanide and the freshwater and saltwater CCC values, 5.2 and 1.0 µg CN/L, respectively, then divided by 1000µg CN/ 1 mg CN, e.g., (5.221 µg CN/L x 1 L/kg) x 1mg CN/1000 µg CN, assuming 1L is approximately 1 kg (see Section 4.4.4).

[c] No chronic dietary toxicity exist for potential surrogate aquatic-dependent species where the dose has been expressed in the desired units of mg/kg food (prey item). Instead, an NOEC value of >2.4 mg/kg food has been estimated from the oral dose (administered via gavage) to male Wistar rats (average weight over the 3 month exposure period of approx. 47 g) at 2.40 mg/kg rat fresh

weight/day, which did not affect their growth. The dietary effects concentration estimated from this study (>2.4 mg/kg food) was estimated assuming a ration of 10% bw/day.

[d] Ranges of toxicity values for food items are provided in the order the food items appear. Ranges are from text box (Section 6.1 of this document), unless indicated otherwise.

N/A indicates that no data are available

4.5 Preliminary Toxicity Assessment Results

This section contains the results of the preliminary screening toxicity assessment. The results are found in Tables 4 (aquatic species) and 6 (aquatic-dependent species), above. These tables in this document correspond with Tables 4.1 and 4.2 in the *BE Methods Manual*. The results of the preliminary screening toxicity assessment are based on the analysis method in Section 4.1 above and Section 3 of the *BE Methods Manual*, producing highly conservative estimates of both acute and chronic toxicity which act as a screen to insure a very low level of risk to the species. Due to the conservative nature of the screen, EPA is confident in making a "not likely to adversely affect" determination for those species which are screened out in the preliminary toxicity assessment without any additional scrutiny. For those species not screened out in this preliminary toxicity assessment, EPA conducted a secondary toxicity assessment and an exposure assessment in order to determine whether EPA's recommended section 304(a) criteria for cyanide would be "likely to adversely affect" those species.

In conducting the aquatic effects assessment, listed freshwater species are assessed only to the freshwater criteria, using freshwater toxicity data, and similarly, listed saltwater species are assessed only to the saltwater criteria, using saltwater data. For listed aquatic species having at least one important life stage in freshwater and at least one important life stage in saltwater, the species will be assessed to both the freshwater and saltwater criteria, using freshwater toxicity data for the freshwater assessment and saltwater data for the saltwater assessment. Whether a listed aquatic species is a freshwater or saltwater species is indicated in Table 4 under the column, 'Freshwater *vs.* Saltwater exposure'. Note that the toxicity data and estimated assessment values in all of the aquatic and aquatic-dependent data tables (i.e., Tables 1, 2, 3, 4, and 6) are expressed as free cyanide.

Based on the results of the preliminary toxicity assessment, EPA determined that cyanide at section 304(a) cyanide aquatic life criteria concentrations would not likely adversely affect all Federally-listed aquatic plant species (Section 3.3 and Table 1), all Federally-listed aquatic-dependent species (Table 6), and most Federally-listed animal species (Table 4). The assessment effects concentrations (EC_As) in Table 4 were below the section 304(a) cyanide aquatic life criteria for 19 darters, 11 trout and salmon, one sturgeon, and one amphipod. Risk to these 32 species is more carefully evaluated in the secondary toxicity assessment, in Section 5.0 and the Exposure Assessment in Section 8.0, below.

The resulting toxicity values (EC_As) of this preliminary toxicity assessment are provided in Tables 4 (aquatic species) and 6(aquatic-dependent species). These tables in this document correspond to Tables 4.1 and 4.2 in the *BE Methods Manual*.

5.0 SECONDARY TOXICITY ASSESSMENT

In Section 4.0, EPA conducted a preliminary toxicity assessment based on the available surrogate data and the analysis methods in Section 3 of the *BE Methods Manual*. The results of the preliminary toxicity assessment allowed EPA, with a high level of confidence given the design of the method, to determine that most of the “may effect” species would not be adversely affected if exposed continuously to cyanide at section 304(a) aquatic life criteria concentrations. However, for 19 darters, 11 trout and salmon, one sturgeon, and one amphipod, as compiled in Table 7, an effects determination could not yet be made and a more detailed toxicity assessment is needed. In this section, EPA conducts a more detailed, secondary toxicity assessment on these 32 species.

In conducting the secondary toxicity assessment on these 32 species, EPA reviewed the available data in greater detail, utilizing those statistics which provide the greatest accuracy and objectivity in making estimates on the sensitivity of the remaining 32 species. This approach is consistent with EPA’s *Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated* (U.S. EPA, 2002). EPA developed these guidelines as directed by the Data Quality Act (2001), which requires Federal agencies to ensure that influential information has a high degree of objectivity, utility, and integrity. Influential information applies to any information that could influence regulatory decisions. EPA’s guidelines indicate that for information to be objective it must be presented in a clear, accurate, complete, and unbiased manner. Further, the presentation of information on environmental risk must be comprehensive, informative, and understandable, and must include the expected risk or central estimates of the specific populations affected or the ecological assessment endpoints. The upper and lower bounds of risk must also be specified.

Accordingly, EPA considered the central tendency as well as the upper and lower confidence bounds in reviewing the results of the ICE models for the secondary toxicity assessment. Based on this range of information, EPA selected the most statistically meaningful number as its best, most objective estimate of toxicity. In general this will be the central tendency of the available data (i.e., the 50^{th} percentile estimates made by the ICE models) since this is generally considered to be the best estimate of the model. In a broad view of the entire assessment process under this biological evaluation (i.e., proceeding through the preliminary toxicity assessment, the secondary toxicity assessment, the exposure assessment, and the final risk determination), EPA is using greater and greater statistical accuracy and objectivity to screen out species that are not likely to be adversely affected.

EPA applied the following rationales in ensuring an objective review and presentation of the data under the secondary screening toxicity assessment.

– Where the assessment effect concentrations (EC_As) are not substantially different than the CMC or the CCC, EPA may make a not likely to adversely affect determination, given that actual exposure will almost certainly be **at least** slightly below the highly conservative exposure assumptions of maximal criteria concentration, frequency, and duration.

– Assuming a normal distribution, the central tendency of the ICE models will be used as the primary statistic in estimating toxicity in the secondary toxicity assessment.

– Although the two primary tools for analyzing surrogate data, ICE and SSD, are expected to be reliable in the majority of cases, they will likely occasionally produce results that are not sufficiently accurate. Accordingly, the geometric mean of all acceptable ICE models (at a given taxonomic level) was used in the secondary toxicity assessment, replacing the single ICE model from the preliminary toxicity assessment. This approach employs the higher confidence provided by a more vigorous statistical approach than used in the preliminary toxicity assessment.

In addition to a statistical analysis of the ICE model estimates as described above, EPA also considered whether toxicity data were available within the taxonomic hierarchy for a given species in Table 1. If toxicity data were available for a species more closely related to the potentially sensitive species than the surrogate species used in the ICE model estimate, EPA may screen out these species on the basis of direct toxicity. This serves as a reality check on the ICE model. If a more closely related species has toxicity data which show the effects concentrations may be much higher than the ICE model estimated effects concentration, then this may indicate that the model results are being biased by chemical toxicity data unrelated to cyanide. In this case, EPA believes that a more accurate determination of whether toxicity is likely to occur must take into account whether toxicity data are available for a species more closely related than the surrogate species used in the ICE model estimate.

The results of the secondary toxicity assessment are provided below, in Table 7. The particular assessment rationales that were applied to the assessment of a each species are provided in the list below.

Individual Species Secondary Toxicity Assessment Results:

<u>Fountain Darter (*Etheostoma fonticola*)</u>: Acute and Chronic Effects Concentrations for the Fountain Darter in the family Percidae were calculated using the species ICE model with the species *Pimephales promelas* in the family Cyprinidae as the surrogate species and the minimum requirement of five chemicals in common. This species may be potentially screened out on the basis of direct toxicity because the available data at the family level, Percidae, (LC50 = 93 and 96 µg/L) indicate that toxicity to this species is likely well above the CMC and CCC for cyanide (see Table 1).

<u>Roanoke Longperch (*Percinia Rex*)</u>: Acute and Chronic Effects Concentrations for the Roanoke Longperch were calculated using the ICE model for the family Percidae with the with the species *Pimephales promelas* in the family Cyprinidae as the surrogate species and a data set with 11 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. In addition, the available data at the family level, Percidae, (LC50 = 93 and 96 µg/L) indicate that toxicity to this species is likely well above the CMC and CCC for cyanide (see Table 1).

Snail Darter (*Percina tonasi*): Acute and Chronic Effects Concentrations for the Snail Darter were calculated using the ICE model for the family Percidae with the species *Pimephales promelas* in the family Cyprinidae as the surrogate species and a data set with 11 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. In addition, the available data at the family level, Percidae, (LC50 = 93 and 96 µg/L) indicate that toxicity to this species is likely well above the CMC and CCC for cyanide (see Table 1).

Cherokee Darter (*Etheostoma scotti*): Acute and Chronic Effects Concentrations for the Cherokee Darter were calculated using the ICE model for the genus Etheostoma in the family Percidae with the species *Pimephales promelas* in the family Cyprinidae and a data set with 10 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. In addition, the available data at the family level, Percidae, (LC50 = 93 and 96 µg/L) indicate that toxicity to this species is likely well above the CMC and CCC for cyanide (see Table 1).

Conasauga Logperch (*Percina jenkinsi*): Acute and Chronic Effects Concentrations for the Conasauga Logperch were calculated using the ICE model for the family Percidae with the species *Pimephales promelas* in the family Cyprinidae as the surrogate species and a data set with 11 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. In addition, the available data at the family level, Percidae, (LC50 = 93 and 96 µg/L) indicate that toxicity to this species is likely well above the CMC and CCC for cyanide (see Table 1).

Goldline Darter (*Percina aurolineata*): Acute and Chronic Effects Concentrations for the Goldline Darter were calculated using the ICE model for the family Percidae with the species *Pimephales promelas* in the family Cyprinidae as the surrogate species and a data set with 11 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. In addition, the available data at the family level Percidae, (LC50 = 93 and 96 µg/L) indicate that toxicity to this species is likely well above the CMC and CCC for cyanide (see Table 1).

Leopard Darter (*Percina pantherina*): Acute and Chronic Effects Concentrations for the Leopard Darter were calculated using the ICE model for the family Percidae with the species *Pimephales promelas* in the family Cyprinidae as the surrogate species and a data set with 11 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. In addition, the available data at the family level

Percidae, (LC50 = 93 and 96 µg/L) indicate that toxicity to this species is likely well above the CMC and CCC for cyanide (see Table 1).

Amber Darter (*Percina antesella*): Acute and Chronic Effects Concentrations for the Amber Darter were calculated using the ICE model for the family Percidae with the species *Pimephales promelas* in the family Cyprinidae as the surrogate species and a data set with 11 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. In addition, the available data at the family level Percidae, (LC50 = 93 and 96 µg/L) indicate that toxicity to this species is likely well above the CMC and CCC for cyanide (see Table 1).

Slackwater Darter (*Etheostoma boschungi*): Acute and Chronic Effects Concentrations for the Slackwater Darter were calculated using the ICE model for the genus Etheostoma in the family Percidae with the species *Pimephales promelas* in the family Cyprinidae and a data set with 10 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. In addition, the available data at the family level Percidae, (LC50 = 93 and 96 µg/L) indicate that toxicity to this species is likely well above the CMC and CCC for cyanide (see Table 1).

Watercress/ Snail Darter (*Etheostoma nuchale*): Acute and Chronic Effects Concentrations for the Watercress/ Snail Darter were calculated using the ICE model for the genus Etheostoma in the family Percidae with the species *Pimephales promelas* in the family Cyprinidae and a data set with 10 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. In addition, the available data at the family level Percidae, (LC50 = 93 and 96 µg/L) indicate that toxicity to this species is likely well above the CMC and CCC for cyanide (see Table 1).

Bayou Darter (*Etheostoma rubrum*): Acute and Chronic Effects Concentrations for the Bayou Darter were calculated using the ICE model for the genus Etheostoma in the family Percidae with the species *Pimephales promelas* in the family Cyprinidae and a data set with 10 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. In addition, the available data at the family level Percidae, (LC50 = 93 and 96 µg/L) indicate that toxicity to this species is likely well above the CMC and CCC for cyanide (see Table 1).

Bluemask Darter (*Etheostoma sp.*): Acute and Chronic Effects Concentrations for the Bluemask Darter were calculated using the ICE model for the genus Etheostoma in the family Percidae with the species *Pimephales promelas* in the family Cyprinidae and a data set with 10 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. In addition, the available data at the family level Percidae, (LC50 = 93 and 96 µg/L) indicate that toxicity to this species is likely well above the CMC and CCC for cyanide (see Table 1).

Boulder Darter (*Etheostoma wapiti*): Acute and Chronic Effects Concentrations for the Boulder Darter were calculated using the ICE model for the genus Etheostoma in the family Percidae with the species *Pimephales promelas* in the family Cyprinidae and a data set with 10 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. In addition, the available data at the family level Percidae, (LC50 = 93 and 96 µg/L) indicate that toxicity to this species is likely well above the CMC and CCC for cyanide (see Table 1).

Duskytail Darter (*Etheostoma percnurum*): Acute and Chronic Effects Concentrations for the Duskytail Darter were calculated using the ICE model for the genus Etheostoma in the family Percidae with the species *Pimephales promelas* in the family Cyprinidae and a data set with 10 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. In addition, the available data at the family level Percidae, (LC50 = 93 and 96 µg/L) indicate that toxicity to this species is likely well above the CMC and CCC for cyanide (see Table 1).

Etowah Darter (*Etheostoma etowahae*): Acute and Chronic Effects Concentrations for the Etowah Darter were calculated using the ICE model for the genus Etheostoma in the family Percidae with the species *Pimephales promelas* in the family Cyprinidae and a data set with 10 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. In addition, the available data at the family level Percidae, (LC50 = 93 and 96 µg/L) indicate that toxicity to this species is likely well above the CMC and CCC for cyanide (see Table 1).

Maryland Darter (*Etheostoma sellare*): Acute and Chronic Effects Concentrations for the Maryland Darter were calculated using the ICE model for the genus Etheostoma in the family Percidae with the species *Pimephales promelas* in the family Cyprinidae and a data set with 10 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. In addition, the available data at the family level Percidae, (LC50 = 93 and 96 µg/L) indicate that toxicity to this species is likely well above the CMC and CCC for cyanide (see Table 1).

Niangua Darter (*Etheostoma nianguae*): Acute and Chronic Effects Concentrations for the Niangua Darter were calculated using the ICE model for the genus Etheostoma in the family

Percidae with the species *Pimephales promelas* in the family Cyprinidae and a data set with 10 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. In addition, the available data at the family level Percidae, (LC50 = 93 and 96 µg/L) indicate that toxicity to this species is likely well above the CMC and CCC for cyanide (see Table 1).

Okaloosa Darter (*Etheostoma okaloosae*): Acute and Chronic Effects Concentrations for the Roanoke Longperch were calculated using the ICE model for the genus Etheostoma in the family Percidae with the species *Pimephales promelas* in the family Cyprinidae and a data set with 10 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. In addition, the available data at the family level Percidae, (LC50 = 93 and 96 µg/L) indicate that toxicity to this species is likely well above the CMC and CCC for cyanide (see Table 1).

Relict Darter (*Etheostoma chienense*): Acute and Chronic Effects Concentrations for the Roanoke Longperch were calculated using the ICE model for the genus Etheostoma in the family Percidae with the species *Pimephales promelas* in the family Cyprinidae and a data set with 10 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. In addition, the available data at the family level Percidae, (LC50 = 93 and 96 µg/L) indicate that toxicity to this species is likely well above the CMC and CCC for cyanide (see Table 1).

Bull Trout (*Salvelinus confluentus*): Acute and Chronic Effects Concentrations for the Bull Trout were calculated using the ICE model for the genus Salvelinus with the species *Oncorhynchus mykiss* in the same family Salmonidae as the surrogate species and a data set with 6 chemicals in common. This species may be screened out because the available data at the genus level, Salvelinus (LC 50 = 86 µg/L) indicate that the toxicity to this species is likely well above the CMC and CCC for cyanide. The observed NOEC at the genus level (6 µg/L) is also above the CCC. (see Table 1).

Chinook Salmon (*Oncorhynchus tshawytscha*): Acute and Chronic Effects Concentrations for the Chinook Salmon were calculated using the species-specific ICE model with the species *Oncorhynchus mykiss* as the surrogate species and a data set with 8 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. In addition, the average of all acceptable ICE estimates (in bold in Table 7) produces EC_As that are sufficiently close to or above the CMC and CCC for cyanide. Also, the available data at the genus level, Oncorhynchus, (range of LC50s from 27 - 97.6 µg/L) are all above the CMC for cyanide. The observed NOEC at the genus level (10 µg/L) is also above the CCC. (see Table 1).

Chum Salmon (*Oncorhynchus keta*): Acute and Chronic Effects Concentrations for the Chum Salmon were calculated using the ICE model for the genus Oncorhynchus with the species *Oncorhynchus mykiss* as the surrogate species and a data set with 35 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. Also, the available data at the genus level Oncorhynchus, (range of LC50s from 27 - 97.6 µg/L) are all above the CMC for cyanide. The observed NOEC at the genus level (10 µg/L) is also above the CCC. (see Table 1).

Coho Salmon (*Oncorhynchus kisutch*): Acute and Chronic Effects Concentrations for the Coho Salmon were calculated using the species-specific ICE model with the species *Oncorhynchus mykiss* as the surrogate species and a data set with 27 chemicals in common. This species may be screened out on the basis of direct toxicity because the average of all acceptable ICE estimates (in bold in Table 7) produces EC_As that are sufficiently close to or above the CMC and CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. Also, the available data at the genus level Oncorhynchus, (range of LC50s from 27 - 97.6 µg/L) are all above the CMC for cyanide. The observed NOEC at the genus level (10 µg/L) is also above the CCC. (see Table 1).

Lahontan Cuttthroat Trout (*Oncorhynchus clarkii henshawi*): Acute and Chronic Effects Concentrations for the Lahontan Cutthroat Trout were calculated using the species-specific ICE model with the species *Oncorhynchus mykiss* as the surrogate species and a data set with 5 chemicals in common. This species may be screened out on the basis of direct toxicity because the average of all acceptable ICE estimates (in bold in Table 7) produces EC_As that are sufficiently close to or above the CMC and CCC for cyanide. Also, the available data at the genus level Oncorhynchus, (range of LC50s from 27 - 97.6 µg/L) are all above the CMC for cyanide. The observed NOEC at the genus level (10 µg/L) is also above the CCC. (see Table 1).

Little Kern Golden Trout (*Oncorhynchus aquabonita whitei*): Acute and Chronic Effects Concentrations for the Little Kern Golden Trout were calculated using the ICE model for the genus Oncorhynchus with the species *Oncorhynchus mykiss* as the surrogate species and a data set with 35 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. Also, the available data at the genus level Oncorhynchus, (range of LC50s from 27 - 97.6 µg/L) are all above the CMC for cyanide. The observed NOEC at the genus level (10 µg/L) is also above the CCC. (see Table 1).

Paiute Cutthroat Trout (*Oncorhynchus clarkii seleniris*): Acute and Chronic Effects Concentrations for the Paiute Cutthroat Trout were calculated using the ICE model for the genus Oncorhynchus with the species *Oncorhynchus mykiss* as the surrogate species and a data set with 35 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. Also, the available data at the genus level Oncorhynchus, (range of LC50s from 27 - 97.6 µg/L) are all above the CMC for cyanide. The observed NOEC at the genus level (10 µg/L) is also above the CCC. (see Table 1).

Sockeye Salmon (*Oncorhynchus nerka*): Acute and Chronic Effects Concentrations for the Sockeye Salmon were calculated using the ICE model for the genus Oncorhynchus with the species *Oncorhynchus mykiss* as the surrogate species and a data set with 35 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. Also, the available data at the genus level Oncorhynchus, (range of LC50s from 27 - 97.6 µg/L) are all above the CMC for cyanide. The observed NOEC at the genus level (10 µg/L) is also above the CCC. (see Table 1).

Greenback Cutthroat Trout (*Oncorhynchus clarkii stomias*): Acute and Chronic Effects Concentrations for the Greenback Cutthroat Trout were calculated using the species-specific ICE model with the species *Oncorhynchus mykiss* as the surrogate species and a data set with 4 chemicals in common which is less than the minimum of 5 required. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. This species may be screened out on the basis of direct toxicity because the average of all acceptable ICE estimates (in bold in Table 7) produces EC_As that are sufficiently close to or above the CMC and CCC for cyanide. Also, the available data at the genus level Oncorhynchus, (range of LC50s from 27 - 97.6 µg/L) are all above the CMC for cyanide. The observed NOEC at the genus level (10 µg/L) is also above the CCC. (see Table 1).

Apache Trout (*Oncorhynchus apache*): Acute and Chronic Effects Concentrations for the Chinook Salmon were calculated using the species-specific ICE model with the species *Oncorhynchus mykiss* as the surrogate species and a data set with 5 chemicals in common. This species may be screened out on the basis of direct toxicity because the available data at the genus level Oncorhynchus, (range of LC50s from 27 - 97.6 µg/L) are all above the CMC for cyanide. The observed NOEC at the genus level (10 µg/L) is also above the CCC. (see Table 1).

Gila Trout (*Oncorhynchus gilae*): Acute and Chronic Effects Concentrations for the Gila Trout were calculated using the ICE model for the genus Oncorhynchus with the species *Oncorhynchus mykiss* as the surrogate species and a data set with 35 chemicals in common. This species may be screened out on the basis of direct toxicity because the EC_As are not substantially different from the CMC or the CCC for cyanide. The ICE model best estimate value is above the CMC and CCC for cyanide. Also, the available data at the genus level Oncorhynchus, (range of LC50s from 27 - 97.6 µg/L) are all above the CMC for cyanide. The observed NOEC at the genus level (10 µg/L) is also above the CCC. (see Table 1).

Shortnose Sturgeon (*Acipenser brevirostrum*): Acute and Chronic Effects Concentrations for the Shortnose Sturgeon were calculated using the species-specific ICE model with the species *Pimephales promelas* as the surrogate species and a data set with 4 chemicals in common which is less than the minimum. This species may potentially be screened out because the closest related organisms in the Class Actinopterygii, for which there are available data (range of LC50s from 27

- 1970 μg/L) are all above the CMC and CCC for cyanide (see Table 1).

Illinois Cave Amphipod (*Gammarus acherondytes*): Acute and Chronic Effects Concentrations for the Illinois Cave Amphipod were calculated using the ICE model for the genus Gammarus with the species *Daphnia magna* as the surrogate species and a data set with 20 chemicals in common. This species may potentially be screened out because the available data at the genus level, Gammarus, (LC50s of 143 and 903 μg/L) are all well above the CMC and CCC for cyanide (see Table 1). Also, the ICE model best estimate value is above the CMC and CCC for cyanide.

Summary

For all 32 species there is some indication, as detailed above, that the concentration necessary to provide a toxic response is most likely at or above EPA's recommended section 304(a) aquatic life criteria for cyanide. EPA believes there is enough evidence provided by the secondary toxicity assessment to screen out all listed species on the basis of direct toxicity and make an effects determination of not likely to be adversely affected by EPA's action of approving State or Tribal water quality standards, or Federal water quality standards promulgated by EPA of aquatic life criteria that are identical to or more stringent than the section 304(a) cyanide aquatic life criteria. However, to provide even more evidence that EPA's action will not adversely affect listed species, EPA made a determination at this point of "potentially screened out" and conducted an exposure assessment in section 8.0 for these 32 species.

Table 7. Secondary Toxicity Assessment for Potentially Sensitive Species (all units in µg CN/L). (Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L). Bold print indicates average of all acceptable ICEs.										
Taxonomy	**Listed Species**	**Acute EC_A (Lower Bound)**	**Acute EC Estimate**	**Acute EC (Upper Bound)**	**Chronic EC_A (Lower Bound)**	**Chronic EC Estimate**	**Chronic EC (Upper Bound)**	**Model**	**Surrogate Species**	**Secondary Toxicity Screen Results**
Chordata Actinopterygii Perciformes Percidae										
	Fountain Darter (*Etheostoma fonticola*)	11.3	18.8	26.2	2.4	4.0	5.6	ICE (species level)	*Pimephales promelas*	Potentially screened out
	Roanoke logperch (*Percina rex*)	20.0	27.3	34.6	4.3	5.9	7.4	ICE (family level)	*Pimephales promelas*	Potentially screened out
	Snail darter (*Percina tanasi*)	20.0	27.3	34.6	4.3	5.9	7.4	ICE (family level)	*Pimephales promelas*	Potentially screened out
	Cherokee darter (*Etheostoma scotti*)	18.9	25.4	32.0	4.0	5.5	6.9	ICE (genus level)	*Pimephales promelas*	Potentially screened out
	Conasauga logperch (*Percina jenkinsi*)	20.0	27.3	34.6	4.3	5.9	7.4	ICE (family level)	*Pimephales promelas*	Potentially screened out
	Goldline darter (*Percina aurolineata*)	20.0	27.3	34.6	4.3	5.9	7.4	ICE (family level)	*Pimephales promelas*	Potentially screened out
	Leopard darter (*Percina pantherina*)	20.0	27.3	34.6	4.3	5.9	7.4	ICE (family level)	*Pimephales promelas*	Potentially screened out
	Amber darter (*Percina antesella*)	20.0	27.3	34.6	4.3	5.9	7.4	ICE (family level)	*Pimephales promelas*	Potentially screened out

Table 7. Secondary Toxicity Assessment for Potentially Sensitive Species (all units in µg CN/L). (Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L). Bold print indicates average of all acceptable ICEs.										
Taxonomy	**Listed Species**	**Acute EC_A (Lower Bound)**	**Acute EC Estimate**	**Acute EC (Upper Bound)**	**Chronic EC_A (Lower Bound)**	**Chronic EC Estimate**	**Chronic EC (Upper Bound)**	**Model**	**Surrogate Species**	**Secondary Toxicity Screen Results**
	Slackwater darter (*Etheostoma boschungi*)	18.9	25.4	32.0	4.0	5.5	6.9	ICE (genus level)	*Pimephales promelas*	Potentially screened out
	Watercress/Snail darter (*Etheostoma nuchale*)	18.9	25.4	32.0	4.0	5.5	6.9	ICE (genus level)	*Pimephales promelas*	Potentially screened out
	Bayou darter (*Etheostoma rubrum*)	18.9	25.4	32.0	4.0	5.5	6.9	ICE (genus level)	*Pimephales promelas*	Potentially screened out
	Bluemask darter (*Etheostoma sp.*)	18.9	25.4	32.0	4.0	5.5	6.9	ICE (genus level)	*Pimephales promelas*	Potentially screened out
	Boulder darter (*Etheostoma wapiti*)	18.9	25.4	32.0	4.0	5.5	6.9	ICE (genus level)	*Pimephales promelas*	Potentially screened out
	Duskytail darter (*Etheostoma percnurum*)	18.9	25.4	32.0	4.0	5.5	6.9	ICE (genus level)	*Pimephales promelas*	Potentially screened out
	Etowah darter (*Etheostoma etowahae*)	18.9	25.4	32.0	4.0	5.5	6.9	ICE (genus level)	*Pimephales promelas*	Potentially screened out
	Maryland darter (*Etheostoma sellare*)	18.9	25.4	32.0	4.0	5.5	6.9	ICE (genus level)	*Pimephales promelas*	Potentially screened out
	Niangua darter (*Etheostoma nianguae*)	18.9	25.4	32.0	4.0	5.5	6.9	ICE (genus level)	*Pimephales promelas*	Potentially screened out

Table 7. Secondary Toxicity Assessment for Potentially Sensitive Species (all units in µg CN/L).
(Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L). Bold print indicates average of all acceptable ICEs.

Taxonomy	Listed Species	Acute EC_A (Lower Bound)	Acute EC Estimate	Acute EC (Upper Bound)	Chronic EC_A (Lower Bound)	Chronic EC Estimate	Chronic EC (Upper Bound)	Model	Surrogate Species	Secondary Toxicity Screen Results
	Okaloosa darter (Etheostoma okaloosae)	18.9	25.4	32.0	4.0	5.5	6.9	ICE (genus level)	*Pimephales promelas*	Potentially screened out
	Relict darter (*Etheostoma chienense*)	18.9	25.4	32.0	4.0	5.5	6.9	ICE (genus level)	*Pimephales promelas*	Potentially screened out
Salmoniformes Salmonidae										
	Bull Trout (*Salvelinus confluentus*)	8.6	17.8	27.1	1.9	3.8	5.8	ICE (genus level)	*Oncorhynchus mykiss*	Potentially screened out
	Chinook Salmon (*Oncorhynchus tshawytscha*)	16.3 **(21.6)**	28.3 **(35.7)**	40.4 **(49.8)**	3.5 **(4.6)**	6.1 **(7.7)**	8.7 **(10.7)**	ICE (species level)	*Oncorhynchus mykiss*	Potentially screened out
	Chum Salmon (*Oncorhynchus keta*)	21.4	25.3	29.1	4.6	5.4	6.3	ICE (genus level)	*Oncorhynchus mykiss*	Potentially screened out
	Coho Salmon (*Oncorhynchus kisutch*)	15.5 **(22.6)**	23.4 **(35.9)**	31.3 **(49.2)**	3.3 **(4.9)**	5.0 **(7.7)**	6.7 **(10.6)**	ICE (species level)	*Oncorhynchus mykiss*	Potentially screened out
	Lahontan Cutthroat Trout (*Oncorhynchus clarkii henshawi*)	11.9 **(15.8)**	18.9 **(26.6)**	26.0 **(37.4)**	2.6 **(3.4)**	4.1 **(5.7)**	5.6 **(8.0)**	ICE (species level)	*Oncorhynchus mykiss*	Potentially screened out
	Little Kern Golden Trout (*Oncorhynchus aquabonita whitei*)	21.4	25.3	29.1	4.6	5.4	6.3	ICE (genus level)	*Oncorhynchus mykiss*	Potentially screened out
	Paiute Cutthroat Trout (*Oncorhynchus clarkii seleniris*)	21.4	25.3	29.1	4.6	5.4	6.3	ICE (genus level)	*Oncorhynchus mykiss*	Potentially screened out

Table 7. Secondary Toxicity Assessment for Potentially Sensitive Species (all units in µg CN/L).
(Freshwater: CMC= 22.4 µg/L, CCC=5.2 µg/L; Saltwater: CMC= 1.0 µg/L; CCC=1.0 µg/L). Bold print indicates average of all acceptable ICEs.

Taxonomy	Listed Species	Acute EC_A (Lower Bound)	Acute EC Estimate	Acute EC (Upper Bound)	Chronic EC_A (Lower Bound)	Chronic EC Estimate	Chronic EC (Upper Bound)	Model	Surrogate Species	Secondary Toxicity Screen Results
	Sockeye Salmon (*Oncorhynchus nerka*)	21.4	25.3	29.1	4.6	5.4	6.3	ICE (genus level)	*Oncorhynchus mykiss*	Potentially screened out
	Greenback Cutthroat Mountain Trout (*Oncorhynchus clarkii stomias*)	15.4 **(20.1)**	18.0 **(28.5)**	20.7 **(36.9)**	3.3 **(4.3)**	3.9 **6.1)**	4.4 **(7.9)**	ICE (species level)	*Oncorhynchus mykiss*	Potentially screened out
	Apache Trout (*Oncorhynchus apache*)	9.1 **(11.8)**	17.1 **(18.7)**	25.1 **(25.6)**	2.0 **(2.5)**	3.7 **(4.0)**	5.4 **(5.5)**	ICE (species level)	*Oncorhynchus mykiss*	Potentially screened out
	Gila Trout (*Oncorhynchus gilae*)	21.4	25.3	29.1	4.6	5.4	6.3	ICE (genus level)	*Oncorhynchus mykiss*	Potentially screened out
Chordata Actinopterygii Acipenseriformes Acipenseridae										
	Shortnose Sturgeon (*Acipenser brevirostrum*)	11.6	14.5	17.5	2.5	3.1	3.8	ICE (species level)	*Pimephales promelas*	Potentially screened out
Arthropoda Malacostraca Amphipoda Gammaridae										
	Illinois Cave Amphipod (*Gammarus acherondytes*)	15.3	32.9	50.4	3.9	8.4	12.9	ICE (genus level)	*Daphnia magna*	Potentially screened out

6.0 ASSESSMENT AND DETERMINATION OF INDIRECT EFFECTS

6.1 Loss of Food Items

For a detailed description of the methodology to assess the toxicity of cyanide at the section 304(a) aquatic life criteria concentrations on food items of aquatic and aquatic-dependent species, refer to Section 5.1 of the *BE Methods Manual*.

Toxicity values for both freshwater and saltwater organisms were identified from Table 1 and grouped into common categories (e.g., insects, invertebrates, fish, etc.). Each respective LC50 value from Table 1 was divided by 2.27 according to the *BE Methods Manual*. The range of EC_A values for these food items are shown in the text box below. Because food items, in and of themselves, are not listed species, the central tendency of the toxicity of each food item, and not the 5th percentile conservative estimates, was used for the assessment. The values from the text box below are applied in Section 4, Table 4 (aquatic species) and Table 6 (aquatic-dependent species) to the Federally-listed species which eat them, for comparison to the CMC and CCC, respectively. Where the lower end of the range falls below the criterion, EPA will evaluate whether a meaningful reduction in a listed species' diet is likely to occur due to toxic effects to its food items and whether likely exposure scenarios will affect the prey organism to the point of adversely affecting the Federally-listed species. As seen in Tables 4 and 6, none of the Federally-listed species are likely to incur an adverse effect from loss of food items due to toxicity to the food items.

Effect Concentrations for Types of Food Items Used in Tables 4 and 6

Organism Type	Acute EC (µg CN/L)	Chronic EC (µg CN/L)
	Freshwater	
Invertebrates	36.6 - 70,484	16.1 - 29[m]
Detritus & Plants	9,867 - 11,453	30 - 200[m]
Algae	1,321	30 - 200[m]
Insect Larvae	73.5 - 881	28.1 - 272[e]
Worms	4,911 - 70,484	1255 - 18,009[m]
Crustaceans	72 - 985	10.8 - 191[m]
Fish	18.2 - 867	5.6 - 110[m]
Plankton	39.6 - 76.2	10.8 - 7029[e]
Amphipods	72.7 - 398	102[e]

Effect Concentrations for Types of Food Items Used in Tables 4 and 6		
Organism Type	**Acute EC (µg CN/L)**	**Chronic EC (µg CN/L)**
	Freshwater	
Copepods	73 - 76	7.1 - 19.5[e]
Snails	90 - 334,801	151 - 85,540[m]
	Saltwater	
Invertebrates	1.85 - 4,405	16.1 - 29[m]
Fish	30.8 - 163	29 - 43[m]
Zooplankton	7.5	7.1[e]
Crustaceans	1.85 - 537	15.5 - 51.8[m]
Red Algae		11[m]
Mussels & Mollusk	4.7 - 6,337	2.1 - 64.2[e]

[m] Measured effects concentration
[e] Estimated chronic effects concentrations are derived from acute-chronic ratios from acute LC50s

6.2 Loss of Glochidia Host Species

EPA evaluated whether cyanide at section 304(a) criteria concentrations is likely to adversely affect freshwater mussels due to toxic effect to the host fish species of glochidia. Glochidia are mussels larvae, which are released by the female mussel to find a suitable fish host for transformation into juvenile mussels. Glochidia attach to the gills or fins of the host fish where they encyst and eventually fall and settle to the bottom as juveniles. Not all fish species can serve as host to a particular mussel species. The life history profiles indicate known host fish species and for which listed mussel species such hosts are obligate species.

Accordingly, EPA determined (1) for which mussel species the life history profiles indicate only one or few fish species (obligate) are known to serve as the host for glochidia and (2) where such a relationship exists, whether it is probable that the obligate host fish species will incur an adverse impact by cyanide at section 304(a) criteria concentrations. EPA used the toxicity information from Appendix A, Table 1, and Table 2 and 3, to determine the sensitivity to obligate species. As with the food item assessment, because obligate host species, in and of themselves, are not listed species, the central tendency of the toxicity of the obligate host species, and not the 5th percentile conservative estimates, is used to assess whether there is an impact. The central tendency acute and chronic EC_A values of obligate fish host species are compared to the section 304(a) acute and chronic cyanide criteria. Where the obligate host species' toxicity falls below the section 304(a) criteria, EPA will evaluate whether likely exposure scenarios will affect the host species to the point of adversely affecting the Federally-listed mussel species.

Based on the life history profiles, there is one mussel species (Fat Pocketbook, *Potamilus capax*) known to have an obligate host fish species (Freshwater drum, *Aplodinotus grunniens Rafinesque*) for glochichia. The best estimates of the acute and chronic EC_As for the Freshwater drum are 65.7 and 18.6 µg/L, respectively, based on the cyanide data from Table 2 for the order *Perciformes*. These acute and chronic EC_As are above the section 304(a) criteria, thus EPA determined that the Fat Pocketbook is not likely to be adversely affected due to the loss of host fish species.

In most instances where host species are identified in the life history profiles, the profiles do not indicate such species to be obligate species, and it is assumed that species other than those listed can serve as host fish species. Although it is possible in some cases that only very sensitive species would serve as host species for a given mussel species, without the supporting data, it is likely that the distribution of host species would include more than just very sensitive species. Appendix E indicates where obligate host species have been identified in the life history profiles and provides the best estimate of the EC_A values for host species in the life history profiles.

7.0 ASSESSMENT OF ADVERSE EFFECTS ON DESIGNATED CRITICAL HABITAT

EPA evaluated whether its approval or promulgation of cyanide section 304(a) aquatic life criteria is likely to adversely affect critical habitat of Federally-listed aquatic or aquatic-dependent species by assessing the impact of the section 304(a) cyanide criteria on the primary constituent elements of the species' critical habitat essential to conserve the species (i.e., "constituent elements"). A complete list of critical habitat and associated critical elements is provided in Appendix B, Part 4, of the *BE Methods Manual*, as gathered from the *Federal Register* listing notices. The constituent elements identified by EPA as those that could be significantly affected are: (1) availability of prey items, (2) presence of aquatic vegetation, and (3) water quality. Because all three of these constituent elements are already addressed in previous sections of this biological evaluation, EPA applied the results of those previous sections to this assessment of critical habitat. That is, the "water quality" constituent element was evaluated by referring to the section on toxicity to aquatic and aquatic-dependent listed species (Sections 4.3 and 4.4, respectively), "availability of prey items" was evaluated by referring to the section on toxicity to food items of listed species" (Section 6.1), and the "presence of aquatic vegetation" was evaluated by referring to the section on toxic effects to aquatic plants (Section 4.3.3). Further, EPA is concluding that its approval or promulgation of section 304(a) aquatic life cyanide criteria will not have any significant effects on all other constituent elements relevant to this biological evaluation, including but not limited to minimum stream flow, water temperature, pH, dissolved oxygen, nutrients, and turbidity.

Based on the assessment of toxicity to food items (Section 6.1 and Tables 4 and 6), EPA determined that significant effects to the constituent element "availability of prey items" (or similar elements) are unlikely. Similarly, based on the assessment of toxicity to aquatic plants (Section 4.3.3 and Tables and 6), EPA determined that significant effects to the constituent element "presence of aquatic vegetation" (or similar elements) are unlikely. Finally, based on the assessment of toxicity to listed species (Tables 1, 4, 6, 7) and where necessary, the assessment of exposure (Table 8), EPA determined that significant effects to the constituent element "water quality" (or similar elements) are unlikely.

8.0 EXPOSURE ASSESSMENT

Introduction

In estimating the potential effect of pollutants on listed species in waterbodies at water quality criteria levels, an essential step for making an accurate assessment is to determine the potential for exposure of a listed species at levels that will be toxic. Without such an exposure assessment, determining the toxicity of any compound in a waterbody to an aquatic organism, including listed species, is speculative. Although the preliminary and secondary toxicity assessments are highly useful for determining water quality criteria concentrations that are fully protective (all species have effects levels above the criteria concentrations) it is not a valid approach for definitively determining the protectiveness of a criterion when a pollutant is shown in the screening steps to have a potential effect concentration below the criterion concentration. This is due to basic toxicological principles that must first be considered.

First, for a toxic effect to occur from a chemical, an exposure to the chemical must occur. Second, even if an exposure occurs, it will not be toxic unless certain factors are met. A species must be subjected to the chemical at the right amount, for the right length of time and at the right occurrence (i.e., toxicity depends on how much, how long and how often an exposure to a toxic contaminant occurs). These are the magnitude, duration and frequency components of all EPA's recommended section 304(a) criteria for toxic chemicals. Without these factors being properly considered through an exposure assessment, a screening level toxicity assessment does not necessarily equate to a toxic effect determination.

In addition to the qualitative information provided in Section 3.0, above, that discusses the importance of an exposure assessment along with the protective factors that are employed by States and Tribes when implementing water quality criteria to help ensure exposures are not toxic, EPA conducted a quantitative exposure assessment. In the following exposure assessment, EPA determined whether the 32 species which were not screened out in the preliminary toxicity screen but could potentially be screened out in the secondary toxicity screen would encounter real-world exposure scenarios of cyanide in "waters of the United States" resulting in toxic conditions. Only current populations of these species and current exposure scenarios were included in the assessment.

The approach consisted of locating, collating, and summarizing the available information regarding the identification or detection of aqueous CN in:

1) State 303(d) lists,
2) Ambient stream monitoring databases (i.e., STORET), and
3) EPA's Permit Compliance System data (PCS), i.e., effluent monitoring data.

In addition to the above, a general literature and internet search for specific cyanide aquatic toxicity to any one of the 32 species was conducted, as well as a search of the various internet pages that focused on threatened and endangered species implicating cyanide, or any other chemical pollutant, as a specific reason for their endangerment.

Critical to identifying receiving waterbodies, and by extension, the listed species that are potentially exposed to CN, the first step involved mapping current species distributions. EPA used various websites such as US FWS, NOAA, USGS and Nature Serve to identify and map (using GIS) the distribution of the 32 species listed in Table 7, the exception being the shortnose sturgeon, which is distributed along the entire East coast. The extent of the distribution was limited to the lower 48 States because none of the 32 species in Table 7 are currently identified as imperiled in Alaska or Hawaii. For this mapping effort, the geographic scope included all sensitive watersheds associated with each of the species (see Figure 2). Counties within or over-lapping each sensitive watershed were identified and matched with each species. Equipped with this list of counties associated with the distribution of each of these cyanide-sensitive species, EPA employed several public data sources to complete the assessment.

Section 303(d) List Internet Fact Sheets

Using the generated species' distribution map(s) and county lists associated with their extant populations, watersheds and waterbodies listed on a given State's or the Federal section 303(d) list because of cyanide were identified and collated. The section 303(d) listings were accessed through EPA's website at: http://www.epa.gov/owow/tmdl/. These section 303(d)-listed watersheds and waterbodies were incorporated into Table 8 where appropriate. There are seven listed species associated with specific waterbodies listed as impaired due to cyanide under Section 303(d). Those species are Greenback Cutthroat Trout, Lahontan Cutthroat Trout, Bull Trout, Chum almon, Coho salmon, Upper and Lower Columbia River Chinook salmon, and Shortnose Sturgeon. The vast majority of those waterbodies (18 of 21) are located in the States of Washington and Oregon. The species potentially affected in those two States are Bull Trout and the three species of sea-run salmon during spawning migration.

STORET and USGS NAWQA Ambient Stream Monitoring Databases

The STORET and USGS NAWQA databases were accessed for historical cyanide monitoring data within the same watersheds where the 32 species are thought to be distributed. Cyanide is not a parameter commonly measured and reported in the USGS NAWQA database, therefore, CN data from USGS NAWQA sites were not found.

A similar search in the STORET database produced ambient monitoring data containing detectable levels of CN for seven waterbodies (six streams and one lake) in five States. These waterbodies are associated with the distribution ranges of only four species which may be potentially affected (California – Chinook Salmon, Sacramento Winter River Run; Colorado - Greenback Cutthroat Trout; Idaho – Bull Trout, and North and South Carolina – Shortnose Sturgeon). The ambient cyanide concentrations in these waterbodies range from a low of 2 µg dissolved CN/L in Dry Creek, CO, to 3,000 µg total CN/L in the Neuse River, North Carolina. This information is incorporated into Table 8 where appropriate.

Note: because of the very large amount of monitoring data for cyanide at extreme low levels, only those waterbodies with measured CN concentrations greater than or equal to 1.9 µg CN/L were compiled. The value 1.9 µg/L represents the lower bound of the chronic effects assessment concentration for Bull Trout. This was the lowest EC_A as calculated by the ICE model for any of the Federally listed species in this BE (see Table 7).

Permit Compliance System (PCS) database

In addition to the above, EPA's PCS database was searched for NPDES permit holders with a CN monitoring requirement or limit in their wastewater permit. Each relevant facility was searched to obtain measurements of CN (see the list below for chemical forms) in their effluent to estimate CN concentrations in receiving waters. These facilities were restricted to those discharging CN into waterbodies within the various watersheds of one or more of the listed species. All PCS query information was collated and used to populate Table 8 below. The total number of dischargers with CN limits and dischargers discharging CN at detectable concentrations to waters in each county were collated as above. The criterion generally used for identifying individual CN dischargers for estimating CN concentrations in ambient receiving waters was that cyanide had to be measured at or above detection levels in multiple sampling events over at least a 3 year period. Once identified, the effluent flow and cyanide monitoring data were compiled for averaging, and used with a measure of average (median) stream flow for estimating ambient cyanide concentrations in these waters.

There are 738 entities (found in 405 counties in 24 States) which discharge to waterbodies identified as having at least one of the 32 listed species and which have cyanide limits or monitoring in their NPDES permits. Only 14 of those discharged consistently quantifiable amounts of cyanide during the last three years (quantification levels ranging from 5 to 50 µg/l). The species potentially affected are Bull Trout, Chinook Salmon, Coho Salmon, Lahontan Cutthroat Trout, Maryland Darter, Duskytail Darter, Niangua Darter, Snail Darter and Shortnose Sturgeon. The estimated downstream concentrations of cyanide are all approximately 1 µg/L, or lower, with the exception of three streams in California: Dry Creek, Laguna Creek and Alamo Creek, and Wilson Creek, Greene County, Missouri. The estimated downstream concentration of cyanide in this four creeks range from 4.9 to 57 µg/L, but all are effluent dominated streams with little or no flow upstream of where the effluent from the wastewater treatment plants (WWTPs) enter. With such little flow upstream of the WWTPs, none of the receiving streams should be expected to host extant populations of listed species (see Table 8). The effluent flow and monitoring data used to calculate receiving water concentrations of CN is provided in Appendix F, and summarized in Table 8 where appropriate. This information was not available for one system, the Hecla Mining Company, Grouse Creek Mine, Challis, ID (permit #: ID0026468). The NPDES permitting authority for this system is EPA Region 10, who is currently consulting with NOAA and the FWS on the potential impacts of CN and other metals to endangered species for this particular permit.

Note: Because of the very large distribution area of the Shortnose Sturgeon, *Acipenser brevirostrum*, a county list of dischargers of cyanide to waters potentially associated with this species was generated only for counties containing waterbodies listed on State section 303(d) lists due to cyanide. The Shortnose Sturgeon inhabits the lower sections of larger rivers and coastal waters along the Atlantic coast. Late juveniles and adults may spend most of the year in brackish or saltwater and move into freshwater only to spawn (catadramous). Fry and juveniles through age 5 are thought to remain in freshwater before returning to saltwater. Only two waterbodies in the Shortnose Sturgeon's range are listed in State section 303(d) lists as impaired by CN: Wills Creek, Allegany County, Maryland, and Cockrell Creek, Northumberland County, Virginia. There is a single discharger of CN in Allegany County, which appears to contain quantifiable CN in their effluent, however, the estimated receiving water cyanide concentration in this water is 0.36 µg/L which is well below the CMC and CCC and Shortnose Sturgeon is not included as threatened or endangered in Maryland. There are no dischargers of CN in Northumberland County, Virginia. Due to the generally very large dilution of chemicals, including CN, discharged directly to saltwater, point source discharge of CN should not directly impact adult Shortnose Sturgeon populations along the Atlantic coast.

Chemical forms of Cyanide Considered for PCS data search.

Chemical Name (Form)	**PCS Parameter Code**
Cyanide	01257
Cyanide, free not amenable to chlorination	81208
Cyanide, free – water plus wastewaters	00719
Cyanide, Total (as CN)	00720
Cyanide, Total Recoverable	78248
Cyanide, weak acid, dissociable	00718
Cyanide, dissolved STD Method	00723
Cyanide, free (Amenable to chlorination)	00722

Other CN aquatic toxicity or related data applicable to listed species

There are little other applicable toxicity data for cyanide pertaining to the 32 species outside of what has already been summarized in Table1 of the BE, except for a single unused study on Coho Salmon by Leduc (1966). The experimental fish were continuously exposed to 0.01, 0.02, 0.04, and 0.08 mg/L cyanide as HCN (nominal) for 24 days. The experiment revealed little impairment of growth in the various groups of salmon by CN. Growth was apparently reduced at the two highest CN concentrations in the first 12 days of the experiment, followed by an accelerated rate of growth in all treatments compared to the control and 0.01 mg CN/L group during the last 12 days of the experiment. Assuming nominal concentrations were close to actual test concentrations, the apparent NOEC for growth of coho salmon following 24 days of exposure exceeded the predicted chronic assessment effects concentration by a factor of 20.

In addition to the above, there are a number of reports of massive fish kills owing to cyanide discharges in rivers and streams (Leduc 1984, Eisler et al. 1991), however, none are specific to any of the 32 listed species. The incidents "…occurred mainly after accidental spills from storage reservoirs of concentrated solutions of NaCN or KCN used by industry, from overturned rail tank cars, from the discharge of substances generating free HCN in the water from hydrolysis or decomposition, or the accidental release of cyanide-containing wastes from a treatment pond" (Leduc, 1984). In all cases, four common characteristics of the spills prevail, consistent with the properties of cyanide: rapid intoxication, short residual time of cyanide in the affected waterbody, moribund fish recover after returning to clean water, and the magnitude of response appears species-dependent owing to differences in species sensitivity (Leduc, 1984). In one very detailed study of fish poisoning due to cyanide, a large quantity of slag from a Japanese gold mine containing CN entered a stream following an earthquake (Yasuno et al., 1981). The slag covered the streambed for up to 10 km from the point of rupture. All biota in the stream were exterminated. Cyanide was detected in the water column for only three days after the spill. Flora was established on the silt covering the streambed after one month, and populations of fish, algae, and invertebrates had recovered after six to seven months, although algae composition was altered.

In a recent report on the population structure and habitat use of Roanoke Logperch (*Percina rex*) prepared by Amanda E. Rosenberger and Paul L. Angermeier for the Virginia Department of Game and Inland Fisheries (Rosenberger and Angermeier, 2002), a chemical spill during 1975 in the middle portion of the Pigg River at Rocky Mountain, Virginia caused a catastrophic fish kill extending 36 km downstream. The authors speculate that this event "likely caused a severe bottleneck in this already stressed population," although no particular chemical, including CN, was singled out as the culprit in their report.

Figure 2: Distribution of Potentially Sensitive Species by Watershed in the Continental United States. In addition, the distribution of the Shortnose Sturgeon encompasses almost the entire Eastern coastline.

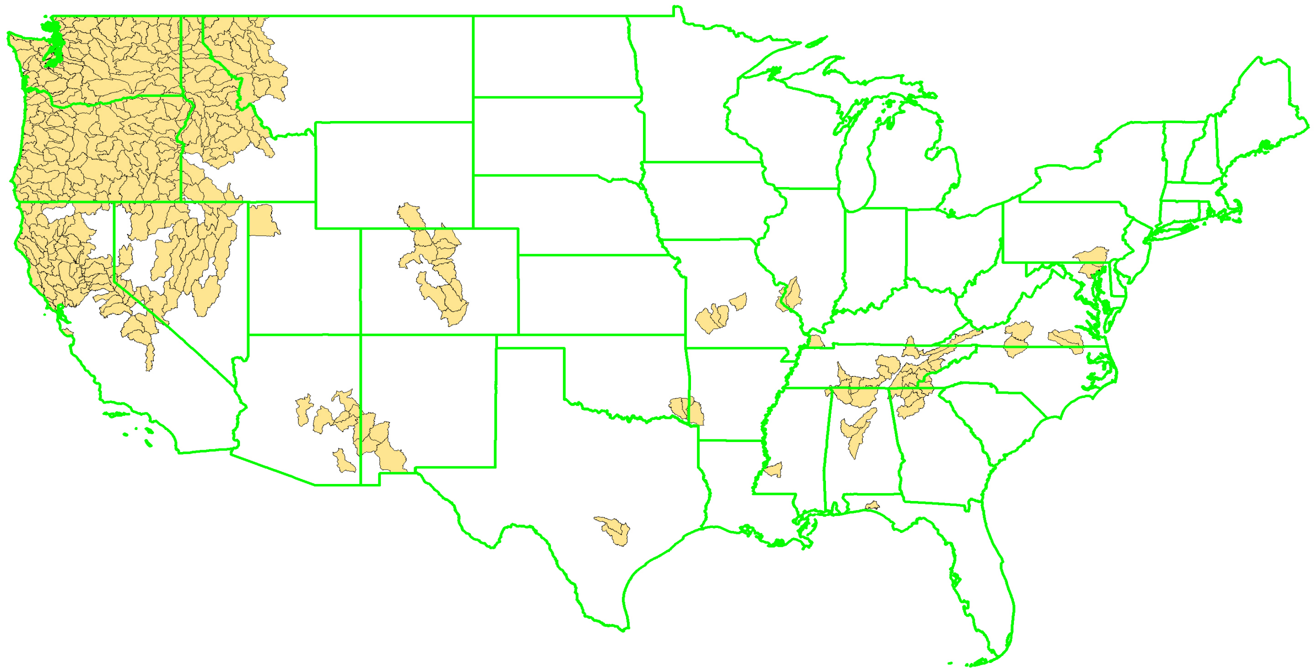

Table 8. Summary of Exposure Assessment Information in Support of the Final Effects Determination for Potentially Sensitive Species.

Taxonomy	Listed Species	Species Distribution (state, # counties)	CN impaired as per 303(d) listing?[a]	No. of Permittees with detectable CN (from PCS)	Estimated [CN] in Receiving Water at low to average flow, µg/L (NPDES # / Receiving water)	Ambient monitoring data[b] available? Waterbody- ([CN], µg/L)	CN as threat to Species[c]	Literature Search Results
Chordata Actinopterygii Perciformes Percidae								
	Fountain Darter (*Etheostoma fonticola*)	Texas- (TX, 12)	No	0 of 1	NA	No	None	None
	Roanoke logperch (*Percina rex*)	Virginia- (VA, 5) North Carolina- (NC, 4)	No	VA- 0 of 7 NC- 0 of 10	NA	No	"a variety of chemical pollutants degrade the species habitat"	Chemical spill implicated in population reduction in 1975. CN not mentioned specifically (Rosenberger and Angermeier, 2002)

Table 8. Summary of Exposure Assessment Information in Support of the Final Effects Determination for Potentially Sensitive Species.								
Taxonomy	**Listed Species**	**Species Distribution (state, # counties)**	**CN impaired as per 303(d) listing?[a]**	**No. of Permittees with detectable CN (from PCS)**	**Estimated [CN] in Receiving Water at low to average flow, µg/L (NPDES # / Receiving water)**	**Ambient monitoring data[b] available? Waterbody- ([CN], µg/L)**	**CN as threat to Species[c]**	**Literature Search Results**
Chordata Actinopterygii Perciformes Percidae	Snail darter (*Percina tanasi*)	Alabama- (AL, 2) Georgia- (GA, 11) North Carolina- (NC, 6) Tennessee- (TN, 23)	No	AL- 0 of 20 GA- 0 of 2 NC- 0 of 4 TN- 2 of 21	See below	No	None	None
		TN- Blount	No	1 of 1	0.0566 NC0025321 Pigeon River	No	None	Discharger in Haywood, NC. Outfall in Blount, TN.
		TN- Loudon	No	1 of 1	0.000139 TN0001449 Tennessee River (Mile 600.1)	No	None	None

Table 8. Summary of Exposure Assessment Information in Support of the Final Effects Determination for Potentially Sensitive Species.

Taxonomy	Listed Species	Species Distribution (state, # counties)	CN impaired as per 303(d) listing?[a]	No. of Permittees with detectable CN (from PCS)	Estimated [CN] in Receiving Water at low to average flow, µg/L (NPDES # / Receiving water)	Ambient monitoring data[b] available? Waterbody- ([CN], µg/L)	CN as threat to Species[c]	Literature Search Results
Chordata Actinopterygii Perciformes Percidae	Cherokee darter (*Etheostoma scotti*)	Georgia- (GA, 14)	No	0 of 5	NA	No	"Agricultural runoff, other pollutants…waste discharges"	None
	Conasauga logperch (*Percina jenkinsi*)	Georgia- (GA, 6) Tennessee- (TN, 2)	No	GA- 0 of 1 TN- 0 of 1	NA	No	None	None
	Goldline darter (*Percina aurolineata*)	Alabama- (AL, 7) Georgia- (GA, 8)	No	AL- 0 of 54 GA- 0 of 1	NA	No	None	None
	Leopard darter (*Percina pantherina*)	Okalahoma - (OK, 2) Arkansas- (AR, 2)	No	OK - 0 of 7 AR - 0 of 2	NA	No	None	None

Table 8. Summary of Exposure Assessment Information in Support of the Final Effects Determination for Potentially Sensitive Species.								
Taxonomy	**Listed Species**	**Species Distribution (state, # counties)**	**CN impaired as per 303(d) listing?[a]**	**No. of Permittees with detectable CN (from PCS)**	**Estimated [CN] in Receiving Water at low to average flow, µg/L (NPDES # / Receiving water)**	**Ambient monitoring data[b] available? Waterbody- ([CN], µg/L)**	**CN as threat to Species[c]**	**Literature Search Results**
Chordata Actinopterygii Perciformes Percidae	Amber darter (*Percina antesella*)	Georgia- (GA, 16) Tennessee- (TN, 2)	No	GA- 0 of 7 TN- 0 of 1	NA	No	"potential threat of a toxic chemical spill"	None
	Slackwater darter (*Etheostoma boschungi*)	Alabama- (AL, 10) Mississippi- (MS, 3) Tennessee- (TN, 10)	No	AL - 0 of 108 MS - 0 of 6 TN- 0 of 5	NA	No	"degradation of surface and ground water caused by the intrusion of toxins"	None
	Watercress/Snail darter (*Etheostoma nuchale*)	Alabama- (AL, 7)	No	0 of 141	NA	No	"Potential chemical spills from highway"	None
	Bayou darter (*Etheostoma rubrum*)	Mississippi- (MS, 5)	No	0 of 11	NA	No	None	None

Table 8. Summary of Exposure Assessment Information in Support of the Final Effects Determination for Potentially Sensitive Species.								
Taxonomy	**Listed Species**	**Species Distribution (state, # counties)**	**CN impaired as per 303(d) listing?[a]**	**No. of Permittees with detectable CN (from PCS)**	**Estimated [CN] in Receiving Water at low to average flow, µg/L (NPDES # / Receiving water)**	**Ambient monitoring data[b] available? Waterbody- ([CN], µg/L)**	**CN as threat to Species[c]**	**Literature Search Results**
	Bluemask darter (*Etheostoma sp.*)	Tennessee- (TN, 12)	No	0 of 9	NA	No	None	None
Chordata Actinopterygii Perciformes Percidae	Boulder darter (*Etheostoma wapiti*)	Alabama- (AL, 2) Tennessee- (TN, 6)	No	0 of 29 0 of 4	NA	No	"toxic chemical spills"	None
	Duskytail darter (*Etheostoma percnurum*)	Kentucky- (KY, 2) North Carolina- (NC, 4) Tennessee- (TN, 23) Virginia- (VA, 9)	No	KY- 0 of 1 NC- 0 of 3 TN- 2 of 20 VA- 0 of 0	See below	No	"vulnerable to extirpation from accidental toxic chemical spills"	None

Table 8. Summary of Exposure Assessment Information in Support of the Final Effects Determination for Potentially Sensitive Species.									
Taxonomy	**Listed Species**	**Species Distribution (state, # counties)**	**CN impaired as per 303(d) listing?[a]**	**No. of Permittees with detectable CN (from PCS)**	**Estimated [CN] in Receiving Water at low to average flow, µg/L (NPDES # / Receiving water)**	**Ambient monitoring data[b] available? Waterbody- ([CN], µg/L)**	**CN as threat to Species[c]**	**Literature Search Results**
		TN- Blount	No	1 of 1	0.0566 NC0025321 Pigeon River	No	None	Discharger in Haywood, NC. Outfall in Blount, TN.
Chordata Actinopterygii Perciformes Percidae		TN- Loudon	No	1 of 1	0.000139 TN0001449 Tennessee River (Mile 600.1)	No	None	None
	Etowah darter (*Etheostoma etowahae*)	Georgia- (GA, 13)	No	GA- 0 of 6	NA	No	None	None
	Maryland darter (*Etheostoma sellare*)	Maryland- (MD, 7) Pennsylvania- (PA, 6)	No	MD- 0 of 21 PA- 2 of 16	See below	No	None	None
		PA- Lancaster	No	1 of 1	0.00442 PA0008508 Conestoga River	No	None	None

Table 8. Summary of Exposure Assessment Information in Support of the Final Effects Determination for Potentially Sensitive Species.								
Taxonomy	**Listed Species**	**Species Distribution (state, # counties)**	**CN impaired as per 303(d) listing?[a]**	**No. of Permittees with detectable CN (from PCS)**	**Estimated [CN] in Receiving Water at low to average flow, µg/L (NPDES # / Receiving water)**	**Ambient monitoring data[b] available? Waterbody- ([CN], µg/L)**	**CN as threat to Species[c]**	**Literature Search Results**
		PA- York	No	1 of 7	0.427 PA0026808 Codorus Creek	No	None	None
Chordata Actinopterygii Perciformes Percidae	Niangua darter (*Etheostoma nianguae*)	Missouri- (MO, 15)	No	1 of 7	See below	No	None	None
		MO- Greene	No	1 of 3	9.77 MO0049522 Wilson Creek	No	None	None
	Okaloosa darter (Etheostoma okaloosae)	Florida- (FL, 2)	No	0 of 0	NA	No	"vulnerability to catastrophic hazardous material spills"	None
	Relict darter (*Etheostoma chienense*)	Kentucky (KY, 8)	No	0 of 9	NA	No	"It is vulnerable to extirpation from accidental, toxic chemical spills"	None

Table 8. Summary of Exposure Assessment Information in Support of the Final Effects Determination for Potentially Sensitive Species.								
Taxonomy	**Listed Species**	**Species Distribution (state, # counties)**	**CN impaired as per 303(d) listing?[a]**	**No. of Permittees with detectable CN (from PCS)**	**Estimated [CN] in Receiving Water at low to average flow, µg/L (NPDES # / Receiving water)**	**Ambient monitoring data[b] available? Waterbody- ([CN], µg/L)**	**CN as threat to Species[c]**	**Literature Search Results**
Salmoniformes Salmonidae	Bull Trout (*Salvelinus confluentus*)	Idaho- (ID, 25) Montana- (MT, 13) Nevada- (NV, 1) Oregon (OR, 23) Washington (WA, 38)	Yes- WA, OR (see Appendix A)	ID- 1 of 9 MT- 1 of 9 NV- 0 of 0 OR- 2 of 17 WA- 0 of 27	See below	No	"poor water quality"	None

Table 8. Summary of Exposure Assessment Information in Support of the Final Effects Determination for Potentially Sensitive Species.								
Taxonomy	**Listed Species**	**Species Distribution (state, # counties)**	**CN impaired as per 303(d) listing?[a]**	**No. of Permittees with detectable CN (from PCS)**	**Estimated [CN] in Receiving Water at low to average flow, µg/L (NPDES # / Receiving water)**	**Ambient monitoring data[b] available? Waterbody- ([CN], µg/L)**	**CN as threat to Species[c]**	**Literature Search Results**
		ID-Custer	No	1 of 1	ID0026468- EPA R10 is currently consulting with FWS and NOAA on this	No	None	None

Table 8. Summary of Exposure Assessment Information in Support of the Final Effects Determination for Potentially Sensitive Species.								
Taxonomy	**Listed Species**	**Species Distribution (state, # counties)**	**CN impaired as per 303(d) listing?[a]**	**No. of Permittees with detectable CN (from PCS)**	**Estimated [CN] in Receiving Water at low to average flow, µg/L (NPDES # / Receiving water)**	**Ambient monitoring data[b] available? Waterbody- ([CN], µg/L)**	**CN as threat to Species[c]**	**Literature Search Results**
		MT- Flathead	No	1 of 3	Within mixing zone: 44.2 Downstream (dst) of mixing zone: <5 MT0030066 Flathead River	No	None	None
Salmoniformes Salmonidae	Bull Trout (*Salvelinus confluentus*)	OR- Klamath Wasco	No	1 of 1 1 of 2	0.843 OR0026301 Klamath River; 0.00204 OR0001708 Columbia River	No	None	None
		ID- Shoshone	No	0 of 2	NA	Yes- Highland Creek 8.1 (total)	None	None

Table 8. Summary of Exposure Assessment Information in Support of the Final Effects Determination for Potentially Sensitive Species.								
Taxonomy	**Listed Species**	**Species Distribution (state, # counties)**	**CN impaired as per 303(d) listing?[a]**	**No. of Permittees with detectable CN (from PCS)**	**Estimated [CN] in Receiving Water at low to average flow, µg/L (NPDES # / Receiving water)**	**Ambient monitoring data[b] available? Waterbody- ([CN], µg/L)**	**CN as threat to Species[c]**	**Literature Search Results**
	Chinook Salmon (*Oncorhynchus tshawytscha*)	California- (CA, 16) Idaho (ID, 6) Oregon- (OR, 14) Washington- (WA, 21)	Yes- WA, OR (see Appendix A)	CA- 4 of 40 ID- 1 of 3 OR- 1 of 14 WA- 0 of 12	See below	See below	None	None
Salmoniformes Salmonidae	Chinook Salmon (*Oncorhynchus tshawytscha*)	CA- Placer	No	1 of 3	12.61 CA0079502 Dry Creek	No	No	None
		CA- Sacramento	No	2 of 4	4.875 CA0081434 Laguna Creek-Consumnes R.; 1.066 CA0077682 Sacramento R.	No	No	There is little to no flow in Laguna Creek upstream of the WWTP outside of a cooling water NPDES discharge (Ranco Seco) which is expected to cease operation in the near future.

Table 8. Summary of Exposure Assessment Information in Support of the Final Effects Determination for Potentially Sensitive Species.								
Taxonomy	Listed Species	Species Distribution (state, # counties)	CN impaired as per 303(d) listing?[a]	No. of Permittees with detectable CN (from PCS)	Estimated [CN] in Receiving Water at low to average flow, µg/L (NPDES # / Receiving water)	Ambient monitoring data[b] available? Waterbody- ([CN], µg/L)	CN as threat to Species[c]	Literature Search Results
		CA- Solano	No	1 of 5	56.79 CA0077691 Alamo Creek	No	No	There is little to no flow in Alamo Creek upstream of the WWTP. Available flow is an average 1 mgd.
		ID- Custer	No	1 of 1	ID0026468- EPA R10 is currently consulting with FWS and NOAA on this system	No	None	None
Salmoniformes Salmonidae	Chinook Salmon (*Oncorhynchus tshawytscha*)	OR- Wasco	No	1 of 2	0.00204 OR0001708 Columbia River	No	None	None
		CA- Shasta	No	0 of 4	NA	Yes- Whiskeytown Lake 30 (total)	None	None

Table 8. Summary of Exposure Assessment Information in Support of the Final Effects Determination for Potentially Sensitive Species.								
Taxonomy	**Listed Species**	**Species Distribution (state, # counties)**	**CN impaired as per 303(d) listing?[a]**	**No. of Permittees with detectable CN (from PCS)**	**Estimated [CN] in Receiving Water at low to average flow, µg/L (NPDES # / Receiving water)**	**Ambient monitoring data[b] available? Waterbody- ([CN], µg/L)**	**CN as threat to Species[c]**	**Literature Search Results**
	Chum Salmon (*Oncorhynchus keta*)	Oregon- (OR, 11) Washington- (WA, 17)	Yes- OR (see Appendix F)	OR- 0 of 22 WA- 0 of 18	NA	No	None	None
	Coho Salmon (*Oncorhynchus kisutch*)	California- (CA, 7) Oregon- (OR, 9)	Yes- OR (see Appendix F)	CA- 0 of 18 OR- 1 of 17	NA	No	None	24- d NOEC (growth) > 0.08 mg CN/L (Leduc 1966)
		OR- Klamath	No	1 of 1	0.843 OR0026301 Klamath River	No	None	None
Salmoniformes Salmonidae	Lahontan Cutthroat Trout (*Oncorhynchus clarkii henshawi*)	California (CA, 11) Nevada- (NV, 16) Utah- (UT, 2) Oregon- (OR, 2)	Yes- NV	CA- 1 of 9 NV- 0 of 4 UT- 0 of 3 OR- 0 of 0	See below	No	None	None

Table 8. Summary of Exposure Assessment Information in Support of the Final Effects Determination for Potentially Sensitive Species.									
Taxonomy	**Listed Species**	**Species Distribution (state, # counties)**	**CN impaired as per 303(d) listing?[a]**	**No. of Permittees with detectable CN (from PCS)**	**Estimated [CN] in Receiving Water at low to average flow, µg/L (NPDES # / Receiving water)**	**Ambient monitoring data[b] available? Waterbody- ([CN], µg/L)**	**CN as threat to Species[c]**	**Literature Search Results**
		CA- Placer	No	1 of 3	12.61 CA0079502 Dry Creek	No	No	Dry creek is an ephermeral stream with a very low flow (average 3.7 mgd) and occasionally no flow during the dry season.
		NV- Humboldt	Humboldt River Basin, Willow Creek	0 of 0	NA	No	None	None
	Little Kern Golden Trout (*Oncorhynchus aquabonit whitei*)	California- (CA, 2)	No	0 of 1	NA	No	None	None
	Paiute Cutthroat Trout (*Oncorhynchus clarkii seleniris*)	California- (CA, 6) Nevada- (NV, 4)	No	CA- 0 of 1 NV- 0 of 1	NA	No	None	None
Salmoniformes Salmonidae	Sockeye Salmon (*Oncorhynchus nerka*)	Idaho- (ID, 2) Washington- (WA, 2)	No	ID- 1 of 1 WA- 0 of 0	NA	No	None	None

Table 8. Summary of Exposure Assessment Information in Support of the Final Effects Determination for Potentially Sensitive Species.									
Taxonomy	**Listed Species**	**Species Distribution (state, # counties)**	**CN impaired as per 303(d) listing?[a]**	**No. of Permittees with detectable CN (from PCS)**	**Estimated [CN] in Receiving Water at low to average flow, µg/L (NPDES # / Receiving water)**	**Ambient monitoring data[b] available? Waterbody- ([CN], µg/L)**	**CN as threat to Species[c]**	**Literature Search Results**
		ID- Custer	No	1 of 1	ID0026468- EPA R10 is currently consulting with FWS and NOAA on this system	No	None	None
	Greenback Cutthroat Mountain Trout (*Oncorhynchus clarkii stomias*)	Colorado- (CO, 16)	See below	12 of 48	NA	See below	None	
		CO- Boulder	No	0 of 5	NA	Yes- Dry Creek 2 (dissolved)		
		CO- Teller	Yes,- Arkansas River Basin, Arequa Gulch, source to Cripple Creek	0 of 4	NA	Yes- Cripple Creek- 18.7 (total) Fourmile Creek- 11.4 (total)		

Table 8. Summary of Exposure Assessment Information in Support of the Final Effects Determination for Potentially Sensitive Species.								
Taxonomy	**Listed Species**	**Species Distribution (state, # counties)**	**CN impaired as per 303(d) listing?[a]**	**No. of Permittees with detectable CN (from PCS)**	**Estimated [CN] in Receiving Water at low to average flow, µg/L (NPDES # / Receiving water)**	**Ambient monitoring data[b] available? Waterbody- ([CN], µg/L)**	**CN as threat to Species[c]**	**Literature Search Results**
		CO- El Paso	No	0 of 12	NA	Yes- Fountain Creek 10 (dissolved)		
Salmoniformes Salmonidae	Greenback Cutthroat Mountain Trout (*Oncorhynchus clarkii stomias*)	CO- Pueblo	No	0 of 5	NA	Yes- Fountain Creek 240 (dissolved)		
	Apache Trout (*Oncorhynchus apache*)	Arizona- (AZ, 9) New Mexico- (NM, 2)	No	AZ- 0 of 43 NM- 0 of 0	NA	No	None	None
	Gila Trout (*Oncorhynchus gilae*)	Arizona- (AZ, 2) New Mexico- (NM, 6)	No	AZ- 0 of 1 NM- 0 of 2	NA	No	"chemical exposure should be of concern since populations are small"	None
Chordata Actinopterygii Acipenseriformes Acipenseridae								
	Shortnose Sturgeon (*Acipenser brevirostrum*)	Entire East coastline	See below	See footnote	NA	See below	None	None

Table 8. Summary of Exposure Assessment Information in Support of the Final Effects Determination for Potentially Sensitive Species.								
Taxonomy	Listed Species	Species Distribution (state, # counties)	CN impaired as per 303(d) listing?[a]	No. of Permittees with detectable CN (from PCS)	Estimated [CN] in Receiving Water at low to average flow, µg/L (NPDES # / Receiving water)	Ambient monitoring data[b] available? Waterbody- ([CN], µg/L)	CN as threat to Species[c]	Literature Search Results
		MD- Allegany	North Br. Potomac, Wills Creek	1 of 1	0.3574 MD0021598 Potomac River, Evitts Creek	No	None	Species is not listed as threatened or endangered in Maryland
		VA- Northumber-land	Chesapeake Bay, Cockrell Creek	0 of 1	NA	No	None	None
Chordata Actinopterygii Acipenseriformes Acipenseridae	Shortnose Sturgeon (*Acipenser brevirostrum*)	NC- Pamlico	No	NA	NA	Yes- Neuse River 2,000 (total)	None	None
		SC- Charleston	No	NA	NA	Yes- Wando River 3.09 (total)	None	None
Arthropoda Malacostraca Amphipoda Gammaridae								

Table 8. Summary of Exposure Assessment Information in Support of the Final Effects Determination for Potentially Sensitive Species.									
Taxonomy	**Listed Species**	**Species Distribution (state, # counties)**	**CN impaired as per 303(d) listing?[a]**	**No. of Permittees with detectable CN (from PCS)**	**Estimated [CN] in Receiving Water at low to average flow, µg/L (NPDES # / Receiving water)**	**Ambient monitoring data[b] available? Waterbody- ([CN], µg/L)**	**CN as threat to Species[c]**	**Literature Search Results**
	Illinois Cave Amphipod (*Gammarus acherondytes*)	Illinois- (IL, 13) Missouri- (MO, 7)	No	IL- 0 of 40 MO- 0 of 16	NA	No	"Main threat = pollution," "possible contaminants... toxic chemicals."	None

a Based on summary of State and Federal 303(d) lists (accessed May 31, 2006)

b Monitoring data from STORET, accessed May 30, 2006. Monitoring data were screened such that only those sites with measured cyanide concentrations equal to or greater than 1.9 µg/L were collated and entered into the summary table. The value of 1.9 µg CN/L was selected as a cutoff for inclusion into Table 8 because it represents the lowest possible cyanide concentration where the effects of cyanide are estimated for a listed species (Bull Trout, *Salvelinus confluentus*) (see Table 7).

c Sources: various Federal and state agency (FWS, DNR) internet sites, accessed May 25 through May 31, 2006

Individual Species Exposure Assessment Results:

Fountain Darter (*Etheostoma fonticola*): The Fountain Darter is potentially found in one counties in the State of Texas in which there are no waterbodies listed as impaired by cyanide. Cyanide is not one of the reasons why this species is listed, nor were any data found in the literature search which indicate that cyanide has affected this species. Within the distribution of the Fountain Darter, there is one permitted discharger for cyanide, however, the concentration of cyanide in the discharge is below the limits of detection. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Fountain Darter is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Roanoke Logperch (*Percinia Rex*): The Roanoke Longperch is potentially found in 5 counties in Virginia and four counties in North Carolina. There are no waterbodies in these States which are listed as impaired due to cyanide. Cyanide is not a specific reason why this species is listed, however, the listing does indicate that a chemical pollution in general degrades the species habitat. The literature search indicated that a chemical spill in 1975 implicated the population, but cyanide was not mentioned specifically as one of the chemicals in the spill. Out of seven permitted cyanide dischargers in Virginia and ten permitted cyanide dischargers in North Carolina, none had levels of cyanide above the detection limits. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Roanoke Logperch is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Snail Darter (*Percina tonasi*): The Snail Darter is potentially found in 2 counties in Alabama, 11 counties in Georgia, 6 counties in North Carolina and 23 counties in Tennessee. No waterbodies in any of these States are listed as impaired due to cyanide. Cyanide is not one of the reasons why this species is listed, nor were any data found in the literature search which indicate that cyanide has affected this species. Within the distribution of the Snail Darter there are 2 permitted dischargers of cyanide out of a total of 47 with levels above the limits of detection. These 2 dischargers are located in the State of Tennessee. The estimated concentrations of cyanide at average flow conditions from the past 3 years of reporting date are 0.0566 and 0.000139 μg/L which is well below any assessment effects concentration predicted by the ICE model or in the available data for this family, Percidae. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Snail Darter is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Cherokee Darter (*Etheostoma scotti*): The Cherokee Darter is potentially found in 14 counties in Georgia in which there are no waterbodies listed as impaired by cyanide. Cyanide is not a specific reason why this species is listed, however, the listing does indicate that agriculture runoff, other pollutants and waste discharges are a threat to this species. No data were found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there are 5 permitted dischargers of cyanide, however, the concentration of cyanide is below the limits of detection. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Cherokee Darter is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Conasauga Logperch (*Percina jenkinsi*):The Conasauga Logperch is potentially found in 6 counties in Georgia and 2 counties in Tennessee. There are no waterbodies in either State listed as impaired by cyanide. Cyanide is not a specific reason why this species is listed, nor were any data found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there are 2 permitted dischargers of cyanide, however, the concentration of cyanide is below the limits of detection. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Conasauga Logperch is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Goldline Darter (*Percina aurolineata*): The Goldline Darter is potentially found in 7 counties in Alabama and 8 counties in Georgia. There are no waterbodies in either State listed as impaired by cyanide. Cyanide is not a specific reason why this species is listed, nor were any data found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there are 55 permitted dischargers of cyanide, however, the concentration of cyanide is below the limits of detection. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Goldline Darter is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Leopard Darter (*Percina pantherina*): The Leopard Darter is potentially found in 2 counties in Oklahoma and 2 counties in Arkansas. There are no waterbodies in either State listed as impaired by cyanide. Cyanide is not a specific reason why this species is listed, nor were any data found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there are 9 permitted dischargers of cyanide, however, the concentration of cyanide is below the limits of detection. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Leopard Darter is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Amber Darter (*Percina antesella*): The Amber Darter is potentially found in 16 counties in Georgia and 2 counties in Tennessee in which there are no waterbodies in either State listed as impaired by cyanide. Cyanide is not a specific reason why this species is listed, however, the listing does indicate that there is a potential threat of a toxic chemical spill that may affect this species. No data were found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there are 8 permitted dischargers of cyanide, however, the concentration of cyanide is below the limits of detection. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Amber Darter is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Slackwater Darter (*Etheostoma boschungi*): The Slackwater Darter is potentially found in 10 counties in Alabama, 3 counties in Mississippi and 10 counties in Tennessee in which there are no waterbodies in any of these States listed as impaired by cyanide. Cyanide is not a specific reason why this species is listed, however, the listing does indicate that degradation of surface and ground water caused by the intrusions of toxins could affect this species. No data were found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there are 119 permitted dischargers of cyanide, however, the concentration of cyanide is below the limits of detection in all cases. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Slackwater Darter is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

<u>Watercress/ Snail Darter (*Etheostoma nuchale*)</u>: The Watercress/ Snail Darter is potentially found in 7 counties in Alabama in which there are no waterbodies listed as impaired by cyanide. Cyanide is not a specific reason why this species is listed, however, the listing does indicate that potential chemical spills from highways may affect this species. No data were found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there are 141 permitted dischargers of cyanide, however, the concentration of cyanide is below the limits of detection in all cases. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Watercress/ Snail Darter is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

<u>Bayou Darter (*Etheostoma rubrum*)</u>: The Bayou Darter is potentially found in 5 counties in Mississippi in which there are no waterbodies listed as impaired by cyanide. Cyanide is not a reason why this species is listed. No data were found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there are 11 permitted dischargers of cyanide, however, the concentration of cyanide is below the limits of detection in all cases. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Bayou Darter is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

<u>Bluemask Darter (*Etheostoma sp.*)</u>: The Bluemask Darter is potentially found in 12 counties in Tennessee in which there are no waterbodies listed as impaired by cyanide. Cyanide is not a reason why this species is listed. No data were found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there are 9 permitted dischargers of cyanide, however, the concentration of cyanide is below the limits of detection in all cases. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Bluemask Darter is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

<u>Boulder Darter (*Etheostoma wapiti*)</u>: The Boulder Darter is potentially found in 2 counties in Alabama and 6 counties in Tennessee in which there are no waterbodies in either State listed as impaired by cyanide. Cyanide is not a specific reason why this species is listed, however, the listing does indicate that toxic chemical spills may affect this species. No data were found in the

literature search which indicate that cyanide has affected this species. Within the distribution of this species there are 33 permitted dischargers of cyanide, however, the concentration of cyanide is below the limits of detection in all cases. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Boulder Darter is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Duskytail Darter (*Etheostoma percnurum*): The Duskytail Darter is potentially found in 2 counties in Kentucky, 4 counties in North Carolina, 23 counties in Tennessee and 9 counties in Virgina. No waterbodies in any of these States are listed as impaired due to cyanide. Cyanide is not one of the reasons why this species is listed, however, the listing indicates that the species is vulnerable to extirpation from accidental toxic chemical spills. No data found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there are 2 permitted dischargers of cyanide out of a total of 24 with levels above the limits of detection. These 2 dischargers are located in the State of Tennessee. The estimated concentrations of cyanide at average flow conditions from the past 3 years of reporting date are 0.0566 and 0.000139 µg/L which is well below any assessment effects concentration predicted by the ICE model or in the available data for this family, Percidae. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Duskytail Darter is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Etowah Darter (*Etheostoma etowahae*): The Etowah Darter is potentially found in 13 counties in Georgia in which there are no waterbodies listed as impaired by cyanide. Cyanide is not a specific reason why this species is listed, nor were any data found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there are 6 permitted dischargers of cyanide, however, the concentration of cyanide is below the limits of detection. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Etowah Darter is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Maryland Darter (*Etheostoma sellare*): The Maryland Darter is potentially found in 7 counties in Maryland and 6 counties in Pennsylvania. No waterbodies in either State are listed as impaired due to cyanide. Cyanide is not one of the reasons why this species is listed, nor was any data found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there are 2 permitted dischargers of cyanide out of a total of 37 with levels above the limits of detection. These 2 dischargers are located in the State of Pennsylvania. The estimated concentrations of cyanide at average flow conditions from the past 3 years of reporting date are 0.00442 and 0.427 µg/L which is well below any assessment effects concentration predicted by the ICE model or in the available data for this family, Percidae. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Maryland Darter is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Niangua Darter (*Etheostoma nianguae*): The Niangua Darter is potentially found in 15 counties in

Missouri in which no waterbodies are listed as impaired due to cyanide. Cyanide is not one of the reasons why this species is listed, nor were any data found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there is 1 permitted discharger of cyanide out of a total of 7 with levels above the limits of detection. The estimated concentrations of cyanide at average flow conditions from the past 3 years of reporting date is 9.77 µg/L which is well below any assessment effects concentration predicted by the ICE model or in the available data for this family, Percidae. Also the Wilson Creek where this permittee is located loses 30% or more of its flow into groundwater or underground caves or channels. The receiving stream is usually a dry creek bed until relatively large WWTP discharge enters. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Niangua Darter is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Okaloosa Darter (*Etheostoma okaloosae*): The Okaloosa Darter is potentially found in 2 counties in Florida in which there are no waterbodies listed as impaired by cyanide. Cyanide is not a specific reason why this species is listed, however, vulnerability to catastrophic hazardous material spills is listed as a threat to the species. No data were found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there are no permitted dischargers of cyanide. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Okaloosa Darter is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Relict Darter (*Etheostoma chienense*): The Relict Darter is potentially found in 8 counties in Kentucky in which there are no waterbodies listed as impaired by cyanide. Cyanide is not a specific reason why this species is listed, however the listing indicates that the species is vulnerable to extirpation from accidental, toxic chemical spills. No data were found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there are 9 permitted dischargers of cyanide, however, the concentration of cyanide is below the limits of detection. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Relict Darter is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Bull Trout (*Salvelinus confluentus*): The Bull Trout is potentially found in 25 counties in Idaho, 13 counties in Montana, 1 county in Nevada, 23 counties in Oregon and 38 counties in Washington. There are waterbodies listed in the States of Washington and Oregon as being impaired due to cyanide. Cyanide is not a specific reason why this species is listed, however poor water quality is listed as a threat to the species. No data were found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there are 4 permitted dischargers of cyanide out of a total of 62 with levels above the limits of detection. These are located in Idaho, Montana and Oregon. The estimated concentration of cyanide from the discharger in Idaho is not currently available, however, the Region 10 office of EPA is currently consulting with the Services on this permit. For the one Montana permittee, the estimated concentrations of cyanide at low flow (worst case) conditions from the past 3 years of reporting is 44.2 µg/L within the mixing zone but less than 5 µg/L downstream of the mixing zone. For the 2 Oregon permittees, the estimated concentrations of cyanide at low flow (worst case) conditions from the past 3 years of reporting are 0.843 and 0.00204 µg/L which is well below any assessment effects concentration predicted by the ICE model or in the available data for this genus, Salvelinus. In the State of Idaho, ambient monitoring data in the Highland Creek showed concentrations of total cyanide of 8.1 µg/L, however, there are no permitted dischargers in this county. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Bull Trout is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Chinook Salmon (*Oncorhynchus tshawytscha*): The Chinook Salmon is potentially found in 16 counties in California, 6 counties in Idaho, 14 counties in Oregon and 21 counties in Washington. There are waterbodies listed in the States of Washington and Oregon as being impaired due to cyanide. Cyanide is not one of the reasons why this species is listed, nor were any data found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there are 6 permitted dischargers of cyanide out of a total of 69 with levels above the limits of detection. These dischargers are located in California, Idaho and Oregon. For the 4 California permittees, the estimated concentrations of cyanide from the past 3 years of reporting are 1.066, 4.875, 12.61 and 56.79 µg/L with zero dilution. The 3 waterbodies upon which these facilities reside are intermittent or ephemeral streams with little to no flow upstream of the wastewater treatment plants and thus it is doubtful that this species resides in these waterbodies. Also, the State of California has reason to believe that the cyanide detected in the effluent of these facilities may be an artifact of the analytical method. This question is currently being explored in a national research study sponsored by the Water Environment Research Foundation (WERF). The estimated concentration of cyanide from the discharger in Idaho is not currently available, however, the Region 10 office of EPA is currently consulting with the Services on this permit. For the discharger is Oregon, the estimated concentrations of cyanide at low flow (worst case) conditions from the past 3 years of reporting was 0.00204 µg/L which is well below any assessment effects concentration predicted by the ICE model or in the available data for this genus, Oncorhynchus. In the State of California, ambient monitoring data in Whiskeytown Lake showed concentrations of total cyanide of 30 µg/L, however, the 4 permitted dischargers in this county do not have detectable levels of cyanide in their discharge. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Chinook Salmon is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Chum Salmon (*Oncorhynchus keta*): The Chum Salmon is potentially found in 11 counties in Oregon and 17 counties in Washington. There are waterbodies listed as impaired by cyanide in the State of Oregon. Cyanide is not a specific reason why this species is listed, nor were any data found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there are 40 permitted dischargers of cyanide, however, the concentration of cyanide is below the limits of detection in all cases. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Chum Salmon is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Coho Salmon (*Oncorhynchus kisutch*): The Coho Salmon is potentially found in 7 counties in California and 9 counties in Oregon. There are waterbodies listed as impaired by cyanide in the State of Oregon. Cyanide is not a specific reason why this species is listed. The literature search found one study which indicate that cyanide a 24 day NOEC for growth is 0.08 mg/L which is well above both the CMC and CCC for cyanide. Within the distribution of this species there is one permitted discharger of cyanide out of a total of 35 with concentration of cyanide above the limits of detection. This discharger is located in Oregon. The estimated concentrations of cyanide at low flow (worst case) conditions from the past 3 years of reporting was 0.843 µg/L which is well below any assessment effects concentration predicted by the ICE model or in the available data for this genus, Oncorhynchus. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Coho Salmon is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Lahontan Cuttthroat Trout (*Oncorhynchus clarkii henshawi*): The Lahontan Cutthroat Trout is potentially found in 11counties in California, 16 counties in Nevada, 2 counties in Utah and 2 counties in Oregon. There are waterbodies listed as impaired by cyanide in the State of Nevada. Cyanide is not a specific reason why this species is listed, nor were any data found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there is one permitted discharger of cyanide out of a total of 16 with a concentration of cyanide above the limits of detection. This discharger is located in California and the estimated concentrations of cyanide from the past 3 years of reporting is 12.61 µg/L with zero dilution. The waterbody upon which this facility resides is an ephemeral streams with little to no flow. Also, the State of California has reason to believe that the cyanide detected in the effluent of these facilities may be an artifact of the analytical method. This question is currently being explored in a national research study sponsored by the Water Environment Research Foundation (WERF). The cyanide impaired water body in Nevada, Humboldt River Basin Willow Creek does not have any permitted dischargers of cyanide. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Lahontan Cutthroat Trout is exposed to toxic conditions of cyanide and

Little Kern Golden Trout (*Oncorhynchus aquabonita whitei*): The Little Kern Golden Trout is potentially found in 2 counties in California in which there are no waterbodies listed as impaired by cyanide. Cyanide is not a specific reason why this species is listed, nor were any data were found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there is one permitted discharger of cyanide, however, the concentration of cyanide is below the limits of detection. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Little Kern Golden Trout is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Paiute Cutthroat Trout (*Oncorhynchus clarkii seleniris*): The Paiute Cutthroat Trout is potentially found in 6 counties in California and 4 counties in Nevada in which there are no waterbodies listed in either State as impaired by cyanide. Cyanide is not a specific reason why this species is listed, nor were any data were found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there are 2 permitted dischargers of cyanide, however, the concentration of cyanide is below the limits of detection. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Paiute Cutthroat Trout is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

<u>Sockeye Salmon (*Oncorhynchus nerka*)</u>: The Sockeye Salmon is potentially found in 2 counties in Idaho and 2 counties in Washington in which there are no waterbodies in either State listed as impaired by cyanide. Cyanide is not a specific reason why this species is listed, nor were any data were found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there is one permitted discharger of cyanide with concentrations of cyanide is below the limits of detection. The estimated concentration of cyanide from the discharger in Idaho is not currently available, however, the Region 10 office of EPA is currently consulting with the Services on this permit. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Sockeye Salmon is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

<u>Greenback Cutthroat Trout (*Oncorhynchus clarkii stomias*)</u>: The Greenback Cutthroat Trout is potentially found in 16 counties of Colorado in which there is one waterbody listed as impaired due to cyanide. Cyanide is not a specific reason why this species is listed, nor were any data were found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there are 12 permitted dischargers of cyanide out of a total of 48 with concentrations of cyanide above the limits of detection. However, the State has indicated to both EPA Region 8 and FWS that the species is not located in the receiving waters of these dischargers. There is ambient monitoring data in 3 counties of Colorado with concentrations of total cyanide of 11.4 and 18.7 µg/L and dissolved cyanide of 2 and 10 µg/L. However, no permitted dischargers out of a total of 26 located in these counties have reported concentrations of cyanide above the limits of detection. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Greenback Cutthroat Trout is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

<u>Apache Trout (*Oncorhynchus apache*)</u>: The Apache Trout is potentially found in 9 counties in Arizona and 2 counties in New Mexico in which there are no waterbodies listed in either State as impaired by cyanide. Cyanide is not a specific reason why this species is listed, nor were any data were found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there are no permitted dischargers of cyanide out of a total of 43 with concentrations of cyanide above the limits of detection. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Apache Trout is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Gila Trout (*Oncorhynchus gilae*): The Gila Trout is potentially found in 2 counties in Arizona and 6 counties in New Mexico in which there are no waterbodies listed in either State as impaired by cyanide. Cyanide is not a specific reason why this species is listed, however, the listing indicates that chemical exposure should be of concern since populations are small. No data were found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there are no permitted dischargers of cyanide out of a total of 3 with concentrations of cyanide above the limits of detection. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Gila Trout is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Shortnose Sturgeon (*Acipenser brevirostrum*): The Shortnose Sturgeon has a distribution of the entire Eastern coastline of the United States. Cyanide is not a specific reason why this species is listed, nor were any data were found in the literature search which indicate that cyanide has affected this species. In Maryland there is one waterbody listed as impaired due to cyanide which contains a permitted discharger with concentrations of cyanide above the limits of detection. The estimated concentration of cyanide at average flow conditions from the past 3 years of reporting is 0.3574 µg/L which is well below any assessment effects concentration predicted by the ICE model or in the available data for the Class Actinopterygii. More frequent monitoring at this location in the past few years have shown concentrations below the detection limit. Also, it should be noted that the Shortnose Sturgeon is not listed as threatened or endangered in the State of Maryland. In Virginia there is also one waterbody listed as impaired due to cyanide which contains a permitted discharger, however, the concentrations of cyanide are below the limits of detection. In North Carolina and South Carolina, there are monitoring data which show concentrations of cyanide of 3.09 and 2000 µg/L however there are no known permitted dischargers of cyanide above the limits of detection nor are there any waterbodies listed as impaired for cyanide in either State. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Shortnose Sturgeon is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Illinois Cave Amphipod (*Gammarus acherondytes*): The Illinois Cave Amphipod is potentially found in 13 counties in Illinois and 7 counties in Missouri in which there are no waterbodies listed in either State as impaired by cyanide. Cyanide is not a specific reason why this species is listed, however, the listing indicates that the main threat to the species is pollution, possible contaminants and toxic chemicals. No data were found in the literature search which indicate that cyanide has affected this species. Within the distribution of this species there are no permitted dischargers of cyanide out of a total of 56 with concentrations of cyanide above the limits of detection. For the reasons above and in combination with the secondary toxicity assessment, it does not appear that the Illinois Cave Amphipod is exposed to toxic conditions of cyanide and therefore is not likely to be adversely affected.

Summary

The information provided above make it clear that the initial assumption in the toxicity assessment of constant exposure to ambient water quality criteria concentrations of cyanide would rarely, if ever, be observed in a waterbody. In order to make final effects determinations in the risk characterization portion of this Biological Evaluation (see section 9.0 below), EPA relied on the toxicity assessment (preliminary and secondary) and the exposure assessment. While the toxicity assessment indicated that the concentrations necessary to cause a toxic response in listed species are above EPA's recommended section 304(a) aquatic life criteria for cyanide, the exposure assessment provided further evidence that there is a low probability that the species in Table 8 will actually be exposed to toxic conditions in waterbodies. The combination of these two assessments give a clear indication that any effect from EPA's action of approving State or Tribal water quality standards, or Federal water quality standards promulgated by EPA of aquatic life criteria that are identical to or more stringent than the section 304(a) cyanide aquatic life criteria will be beneficial, discountable or insignificant to listed species.

9.0 RISK CHARACTERIZATION: EFFECTS DETERMINATION

9.1 No Effect Determinations

From the initial list of 555 Federally-listed species (Appendix B of the *BE Methods Manual*), EPA is making a "no effect" determination for the 109 species that are considered terrestrial or have only limited exposure to "waters of the U.S." The names of these species for which this effect determination has been made are listed below with both common and scientific names.

MAMMALS

Point Arena Mountain beaver	*Aplodontia rufa nigra*
Choctawatchee beach mouse	*Peromyscus polionotus allophrys*
Alabama beach mouse	*Peromyscus polionotus ammobates*
Peridido Key beach mouse	*Peromyscus polionotus trissyllepsis*
St. Andrew beach mouse	*Peromyscus polionotus peninsularis*
Sierra Nevada bighorn sheep	*Ovis candensis scirpensis*

BIRDS

Mariana mallard	*Anas oustaleti*
Hawaiian goose	*Nesoshen sandvicensis*
California condor	*Gymnogyps californianus*
Guam micronesian kingfisher	*Halcyon cinnamomina cinnamomina*
Northern aplomado falcon	*Falco femoralis septentrionalis*
San Clemente loggerhead shrike	*Lanius ludovicianus mearnsi*

Guam rail	*Rallus owstoni*

REPTILES

Bluetail mole skink	*Eumeces egregius lividus*

AMPHIBIANS

Golden coqui	*Eleutherodactylus jasperi*
Mississippi gopher frog	*Rana capito sevosa*
Red Hills salamander	*Phaeognathus hubrichti*
Shenandoah salamander	*Plethodon shenandoah*
Puerto Rican crested toad	*Peltophryne lemur*

GASTROPODS

Painted snake coiled forest snail	*Anguispira picta*
Iowa Pleistocene snail	*Discus macclintocki*
Morro shoulderband snail	*Helminthoglypta walkeriana*
Noonday snail	*Mesodon clarki nantahala*
Virginia fringed mountain snail	*Polygyriscus virginianus*

INSECTS

Helotes mold beetle	*Batrisodes venyivi*
Valley Elderberry Longhorn beetle	*Desmocerus californicus dimorphus*
Ground beetle	*Rhadine infernalis*
Ground beetle	*Rhadine exilis*
Tooth Cave ground beetle	*Rhadine persephone*
Oregon silverspot butterfly	*Speyeria zerene hippolyta*
Kretschmarr Cave mold beetle	*Texamaurops reddelli*

ARACHNIDS

Kauai cave wolf spider	*Adelocosa anops*
Tooth Cave spider	*Neoleptoneta myopica*
Tooth Cave pseudoscorpion	*Tartarocreagis texana*
Bone Cave harvestman	*Texella reyesi*
Redell harvestman	*Texella reddelli*
Braken Bat Cave meshweaver	*Cicurina venii*
Cokendolpher Cave harvestman	*Texella cokendolheri*

Government Canyon Bat Cave meshweaver	*Cicurina vespera*
Madla's Cave meshweaver	*Cicurina madla*
Robber Baron Cave meshweaver	*Cicurina baronia*
Government Canyon cave spider	*Neoleptoneta microps*

PLANTS

Sonoma alopecurus	*Alopecurus aequalis sonomensis*
Kuawawaenohu	*Alsinidendron lychnoides*
(no common name)	*Alsinidendron viscosum*
Seabeach amaranth	*Amaranthus pumilus*
Price's potato bean	*Apios priceana*
Applegate's milk-vetch	*Astragalus applegatei*
Ventura marsh milk-vetch	*Astragalus pycnostachyus var. lanosissimus*
Jesup's milk-vetch	*Astragalus robbinsii jesupi*
Capa rose	*Callicarpa ampla*
Manac palm	*Calyptronoma rivalis*
White sedge	*Carex albida*
Golden paintbrush	*Castilleja levisecta*
Pitcher's thistle	*Cirsium pitcheri*
Florida perforate cladonia	*Cladonia perforata*
Morefield's leather-flower	*Clematis morefieldii*
'Oha wai	*Clermontia drepanomorpha*
'Oha wai	*Clermontia oblongifolia brevipes*
Apalachicola rosemary	*Conradina glabra*
Cumberland rosemary	*Conradina verticallata*
Palmate-bracted bird's-beak	*Cordylanthus palmatus*
Palo de Nigua	*Cornutia obovata*
Haha	*Cyanea macrostegia gibonsii*
Ha'iwale	*Cyrtandra viridiflora*
Oha	*Delissea rivularis*
Na'ena'e	*Dubautia pauciflorula*
Minnesota dwarf trout lily	*Erythronium propullans*
Uvillo	*Eugenia haematocarpa*
Cook's holly	*Ilex cookii*
Sintenis' holly	*Ilex sintenisii*
Dwarf lake iris	*Iris lacustris*

Cooley's water-willow	*Justicia cooleyi*
Sebastopol meadowfoam	*Limnanthes vinculans*
(no common name)	*Lobelia oahuensis*
Alani	*Melicope lydgatei*
Willowy monardella	*Monardella linoides viminea*
Kolea	*Myrsine juddii*
Kolea	*Myrsine linearifolia*
Papery whitlow-wort	*Paronychia chartacea*
Furbish lousewart	*Pedicularis furbishiae*
Ruth's golden aster	*Pityopsis ruthii*
Calistoga allocarya	*Plagiobothrys strictus*
Western Prairie fringed orchid	*Platanthera praeclara*
Chupacallos	*Pleodendron macranthum*
Mann's bluegrass	*Poa mannii*
Napa bluegrass	*Poa nepensis*
Hawaiian bluegrass	*Poa sandvicensis*
(no common name)	*Poa siphonoglossa*
San diego mesa mint	*Pogogyne abramsii*
Lo'ulu	*Pritchardia munroi*
Lo'ulu	*Pritchardia viscosa*
Homboldt's rollandia	*Rollandia humboldtiana*
St. John's rollandia	*Rollandia St. John*
Fringed campion	*Silene polypetala*
Gentian pinkroot	*Spigelia gentianoides*
Palo de jazmin	*Styrax portoricensis*
Texas snowbells	*Styrax texana*
California taraxacum	*Taraxacum californicum*
Palo colorado	*Ternstroemia luquillensis*
(no common name)	*Ternstroemia subsessilis*
'Ohe'ohe	*Tetraplasandra gymnocarpa*
Howell's spectacular thelypody	*Thelypodium howellii spectabilis*
Florida torreya	*Torreya taxifolia*
(no common name)	*Trematolobelia singularis*
Relict trillium	*Trillium reliquum*
Solano grass	*Tuctoria mucronata*
Forbes violet	*Viola oahuensis*

Maua	*Xylosma crenatum*

The list of such species is also included in Appendix B, Part 3, of the *BE Methods Manual* along with more detailed information regarding why this determination was made.

9.2 May Effect Determinations

From the initial list of 555 Federally-listed species (Appendix B of the *BE Methods Manual*), EPA made a "may effect" determination and conducted an effects assessment on the 445 listed aquatic and aquatic-dependent species that have more than a limited exposure to "waters of the U.S." In order to make an effects determination due to direct toxicity to Federally-listed aquatic and aquatic-dependent species, EPA conducted a highly conservative, preliminary screening toxicity assessment, based on a conservative assessment of toxicity, to identify which of the 446 species would not be adversely affected by EPA approval or promulgation of section 304(a) cyanide criteria based on the available surrogate toxicity data and the analysis methods as specified in the *BE Methods Manual*. The results of the preliminary toxicity screen are found in Section 4.0 of this document. In addition, in order to determine whether indirect effects to the same 446 Federally-listed aquatic and aquatic-dependent species would occur, EPA assessed whether EPA approval or promulgation of section 304(a) cyanide criteria would adversely affect the availability of food items or host species for glochidia of freshwater mussels. The results of the assessment of indirect effects are found in Section 6.0 of this document.

9.2.1 May Affect, Not Likely to Adversely Affect Determinations:

After conducting the preliminary toxicity assessment and assessment of indirect effects, EPA was able to screen out and make an effects determination of may affect, not likely to adversely affect for 414 Federally listed aquatic and aquatic-dependent species. The names of these species for which this effect determination has been made are listed below with both common and scientific names. The data supporting this decision on all aquatic plants listed below is in Section 4.3.3.

MAMMALS

Guadalupe fur seal	*Arctocephalus townsendi*
Sei whale	*Balaenoptera borealis*
Blue whale	*Balaenoptera musculus*
Bowhead whale	*Balaena mysticetus*
Finback whale	*Balaenoptera physalus*
Virginia big-eared bat	*Corynorhinus townsendii virginianus*

Southern sea otter	*Enhydra lutris nereis*
Northern Atlantic right whale	*Eubalaena glacialis*
Stellar sea lion	*Eumetopias jubatus*
Hawaiian hoary bat	*Lasiurus cinereus semotus*
Humpback whale	*Megaptera novaeangliae*
Amargosa vole	*Microtus californicus scirpensis*
Florida salt marsh vole	*Microtus pennsylvanicus dukecampbelli*
Caribbean monk seal	*Monachus tropicalus*
Hawaiian monk seal	*Monachus schauinslandi*
Gray bat	*Myotis grisescens*
Indiana bat	*Myotis sodalis*
Riparian woodrat	*Neotoma fuscipes riparia*
Gulf of California harbor porpoise	*Phocoena sinus*
Sperm whale	*Physeter macrocephalus*
Florida panther	*Puma concolor coryi*
Salt marsh harvest mouse	*Reithrodontomys raviventris*
West Indian manatee	*Trichechus manatus*
Grizzly bear	*Ursus arctos horribilis*
Louisiana black bear	*Ursus americanus luteolus*

BIRDS

Hawaiian duck	*Anas wyvilliana*
Laysan duck	*Anas laysanensis*
Marbled murrelet	*Brachyramphus marmoratus marmoratus*
Aleutian Canada goose	*Branta canadensis leucopareia*
Piping plover	*Charadrius melodus*
Western snowy plover	*Charadrius alexandrinus nivosus*
Southwestern willow flycatcher	*Empidonax traillii extimus*
Hawaiian coot	*Fulica americana alai*
Mariana common moorhen	*Gallinula chloropus guami*
Hawaiian common moorhen (gallinule)	*Gallinula chloropus sandvicensis*
Whooping crane	*Grus americana*
Mississippi sandhill crane	*Grus canadensis pulla*
Bald eagle	*Haliaeetus leucocephalus*
Hawaiian stilt	*Himantopus mexicanus knudseni*
Wood stork	*Mycteria americana*

Eskimo curlew	*Numenius borealis*
Brown pelican	*Pelecanus occidentalis*
Short-tail albatross	*Phoebastria albatrus*
Audubon's crested caracara	*Polyborus plancus audubonii*
Steller's eider	*Polysticta stelleri*
Hawaiian dark-rumped petrel	*Pterodroma phaeopgyia sandwichensis*
Newell's Townsend shearwater	*Puffinus auricularis newelli*
California clapper rail	*Rallus longirostris obsoletus*
Light-footed clapper rail	*Rallus longirostris levipes*
Yuma clapper rail	*Rallus longirostris yumanensis*
Everglades snail kite	*Rostrhamus sociabilis plumbeus*
Spectacled eider	*Somateria fischeri*
Least tern	*Sterna antillarum*
California least tern	*Sterna antillarum browni*
Roseate tern	*Sterna dougalli dougalli*
Least Bell's vireo	*Vireo bellii pusillus*

REPTILES

Loggerhead sea turtle	*Caretta caretta*
Green sea turtle	*Chelonia mydas*
Bog turtle	*Clemmys muhlenbergii*
American crocodile	*Crocodylus acutus*
Leatherback sea turtle	*Dermochelys coriacea*
Hawksbill sea turtle	*Eretmochelys imbricata*
Yellow-blotched map turtle	*Graptemys flavimaculata*
Ringed map turtle	*Graptemys oculifera*
Kemp's ridley sea turtle	*Lepidochelys kempii*
Olive ridley sea turtle	*Lepidochelys olivacea*
Atlantic salt marsh snake	*Nerodia clarkii taeniata*
Northern copperbelly water snake	*Nerodia erythrogaster neglecta*
Concho water snake	*Nerodia paucimaculata*
Lake Erie water snake	*Nerodia sipedon insularum*
Alabama redbelly turtle	*Pseudemys alabamensis*
Plymouth redbelly turtle	*Pseudemys rubriventris bangsi*
Flattened musk turtle	*Sternotherus depressus*
Giant garter snake	*Thamnophis gigas*

San Francisco garter snake	*Thamnophis sirtalis tetrataenia*

AMPHIBIANS

California tiger salamander	*Ambystoma californiense*
Santa Cruz long-toed salamander	*Ambystoma macrodactylum croceum*
Flatwoods salamander	*Ambystoma reliquum (cingulatum)*
Sonoran tiger salamander	*Ambystoma tigrinum stebbinsi*
Desert slender salamander	*Batrachoseps aridus*
Wyoming toad	*Bufo hemiophrys baxteri*
Houston toad	*Bufo houstonensis*
Arroyo toad	*Bufo microscaphus californicus*
San Marcos salamander	*Eurycea nana*
Barton Springs salamander	*Eurycea sosorum*
California red-legged frog	*Rana aurora draytonii*
Texas blind salamander	*Typhlomolge rathbuni*

FISHES

Gulf sturgeon	*Acipenser oxyrinchus desotoi*
Kootenai River white sturgeon	*Acipenser transmontanus*
Ozark cavefish	*Amblyopsis rosae*
Modoc sucker	*Catostomus microps*
Santa Ana sucker	*Catostomus santaanae*
Warner sucker	*Catostomus warnerensis*
Shortnose sucker	*Chasmistes brevirostris*
Cui-ui	*Chasmistes cujus*
June sucker	*Chasmistes liorus*
Pygmy sculpin	*Cottus paulus*
White River springfish	*Crenichthys baileyi baileyi*
Hiko White River springfish	*Crenichthys baileyi grandis*
Railroad Valley springfish	*Crenichthys nevadae*
Totoaba	*Cynoscion macdonaldi*
Blue shiner	*Cyprinella caerulea*
Beautiful shiner	*Cyprinella formosa*
Spotfin chub	*Cyprinella monacha*
Leon Springs pupfish	*Cyprinodon bovinus*
Devils Hole pupfish	*Cyprinodon diabolis*

Comanche Springs pupfish	*Cyprinodon elegans*
Desert pupfish	*Cyprinodon macularius*
Ash Meadows Amargosa pupfish	*Cyprinodon nevadensis mionectes*
Warm Springs pupfish	*Cyprinodon nevadensis pectoralis*
Owens pupfish	*Cyprinodon radiosus*
Lost River sucker	*Deltistes luxatus*
Devils River minnow	*Dionda diaboli*
Pahrump poolfish	*Empetrichthys latos*
Desert dace	*Eremichthys acros*
Slender chub	*Erimystax cahni*
Tidewater goby	*Eucyclogobius newberryi*
Big Bend gambusia	*Gambusia gaigei*
San Marcos gambusia	*Gambusia georgei*
Clear Creek gambusia	*Gambusia heterochir*
Pecos gambusia	*Gambusia nobilis*
Unarmored threespine stickleback	*Gasterosteus aculeatus williamsoni*
Hutton tui chub	*Gila bicolor ssp.*
Mohave tui chub	*Gila bicolor mohavensis*
Owens tui chub	*Gila bicolor snyderi*
Borax Lake chub	*Gila boraxobius*
Humpback chub	*Gila cypha*
Sonora chub	*Gila ditaenia*
Bonytail chub	*Gila elegans*
Chihuahua chub	*Gila nigrescens*
Yaqui chub	*Gila purpurea*
Pahranagat roundtail chub	*Gila robusta jordani*
Virgin River chub	*Gila robusta seminuda*
Rio Grande silvery minnow	*Hybognathus amarus*
Delta smelt	*Hypomesus transpacificus*
Yaqui catfish	*Ictalurus pricei*
White River spinedace	*Lepidomeda albivallis*
Big Spring spinedace	*Lepidomeda mollispinis pratensis*
Little Colorado spinedace	*Lepidomeda vittata*
Spikedace	*Meda fulgida*
Waccamaw silverside	*Menidia extensa*
Moapa dace	*Moapa coriacea*

Palezone shiner	*Notropis albizonatus*
Cahaba shiner	*Notropis cahabae*
Arkansas River shiner	*Notropis girardi*
Cape Fear shiner	*Notropis mekistocholas*
Pecos bluntnose shiner	*Notropis simus pecosensis*
Topeka shiner	*Notropis topeka*
Smoky madtom	*Noturus baileyi*
Yellowfin madtom	*Noturus flavipinnis*
Neosho madtom	*Noturus placidus*
Pygmy madtom	*Noturus stanauli*
Scioto madtom	*Noturus trautmani*
Steelhead trout	*Oncorhynchus mykiss*
Oregon chub	*Oregonichthys crameri*
Blackside dace	*Phoxinus cumberlandensis argentissimus*
Woundfin	*Plagopterus*
Gila topminnow	*Poeciliopsis occidentalis occidentalis*
Yaqui topminnow	*Poeciliopsis occidentalis sonoriensis*
Sacramento splittail	*Pogonichthys macrolepidotus*
Smalltooth Sawfish	*Pristis pectinata*
Colorado pikeminnow	*Ptychocheilus lucius*
Foskett speckled dace	*Rhinichthys osculus ssp.*
Independence Valley speckled dace	*Rhinichthys osculus lethoporus*
Ash Meadows speckled dace	*Rhinichthys osculus nevadensis*
Clover Valley speckled dace	*Rhinichthys osculus oligoporus*
Kendall Warm Springs dace	*Rhinichthys osculus thermalis*
Alabama cavefish	*Speoplatyrhinus poulsoni*
Alabama sturgeon	*Scaphirhynchus suttkusi*
Pallid sturgeon	*Scaphirhynchus albus*
Atlantic salmon	*Salmo salar*
Loach minnow	*Tiaroga cobitis*
Razorback sucker	*Xyrauchen texanus*

CRUSTACEANS

Madison cave isopod	*Antrolana lira*
Conservancy fairy shrimp	*Branchinecta conservatio*
Longhorn fairy shrimp	*Branchinecta longiantenna*

Vernal pool fairy shrimp	*Branchinecta lynchi*
San Diego fairy shrimp	*Branchinecta sandiegoensis*
Cave crayfish	*Cambarus aculabrum*
Cave crayfish	*Cambarus zophonastes*
Vernal pool tadpole shrimp	*Lepidurus packardi*
Lee County cave isopod	*Lirceus usdagalun*
Nashville crayfish	*Orconectes shoupi*
Shasta crayfish	*Pacifastacus fortis*
Alabama cave shrimp	*Palaemonias alabamae*
Squirrel chimney cave shrimp	*Palaemonetes cummingi*
Kentucky cave shrimp	*Palaemonias ganteri*
Kauai cave amphipod	*Spelaeorchestia koloana*
Riverside fairy shrimp	*Streptocephalus woottoni*
Hay's Spring amphipod	*Stygobromus hayi*
Peck's cave amphipod	*Stygobromus pecki*
California freshwater shrimp	*Syncaris pacifica*
Socorro isopod	*Thermosphaeroma thermophilus*

GASTROPODS

Anthony's riversnail	*Athearnia anthonyi*
Slender campeloma	*Campeloma decampi*
Lacy elimia	*Elimia crenatella*
Newcomb's snail	*Erinna newcombi*
Idaho springsnail	*Fontelicella idahoensis*
Banbury springs limpet	*Lanx sp.*
Cylindrical lioplax	*Lioplax cyclostomaformis*
Round rocksnail	*Leptoxis ampla*
Plicate rocksnail	*Leptoxis plicata*
Painted rocksnail	*Leptoxis taeniata*
Flat pebblesnail	*Lepyrium showalteri*
Kanab ambersnail	*Oxyloma haydenai kanabensis*
Snake river physa	*Physa natricina*
Bruneau hot springsnail	*Pyrgulopsis bruneauensis*
Socorro springsnail	*Pyrgulopsis neomexicana*
Royal snail (Marstonia)	*Pyrgulopsis ogmoraphe*
Armored snail	*Pyrgulopsis pachyta*

Chittenago ovate amber snail	*Succinea chittenagoensis*
Bliss Rapids snail	*Taylorconcha serpenticola*
Tulotama snail	*Tulotoma magnifica*
Utah valvata snail	*Valvata ytahensis*

INSECTS

Ash Meadows naucorid bug	*Ambrysus amargosus*
Hungerford's crawling water beetle	*Brychius hungerfordi*
Northeastern beach tiger beetle	*Cicindela dorsalis dorsalis*
Puritan tiger beetle	*Cicindela puritana*
Delta green ground beetle	*Elaphrus viridis*
Comal Springs riffle beetle	*Heterelmis comalensis*
Lotis blue butterfly	*Lycaeides argyrognomon lotis*
St. Francis' satyr butterfly	*Neonympha mitchellii francisci*
Mitchell's satyr butterfly	*Neonympha mitchellii mitchellii*
Hine's emerald dragonfly	*Somatochlora hineana*
Comal springs dryopid beetle	*Stygoparnus comalensis*

BIVALVES

Cumberland elktoe	*Alasmidonta atropurpurea*
Dwarf wedgemussel	*Alasmidonta heterodon*
Appalachian elktoe	*Alasmidonta raveneliana*
Fat three-ridge	*Amblema neislerii*
Ouachita rock pocketbook	*Arkansia wheeleri*
Fanshell	*Cyprogenia stegaria*
Dromedary pearlymussel	*Dromus dromas*
Chipola slabshell	*Elliptio chipolaensis*
Tar River spinymussel	*Elliptio steinstansana*
Purple bankclimber	*Elliptoideus sloatianus*
Cumberlandian combshell	*Epioblasma brevidens*
Oyster mussel	*Epioblasma capsaeformis*
Curtis pearlymussel	*Epioblasma florentina curtisii*
Yellow blossom	*Epioblasma florentina florentina*
Tan riffleshell	*Epioblasma florentina walkeri*
Upland combshell	*Epioblasma metastriata*

Catspaw	*Epioblasma obliquata obliquata*
White catspaw	*Epioblasma obliquata perobliqua*
Southern acornshell	*Epioblasma othcaloogensis*
Southern combshell	*Epioblasma penita*
Green blossom	*Epioblasma torulosa gubernaculum*
Northern riffleshell	*Epioblasma torulosa rangiana*
Tubercled blossom	*Epioblasma torulosa torulosa*
Turgid blossom	*Epioblasma turgidula*
Shiny pigtoe	*Fusconaia cor*
Finerayed pigtoe	*Fusconaia cuneolus*
Cracking pearlymussel	*Hemistena lata*
Pink mucket	*Lampsilis abrupta*
Fine-lined pocketbook	*Lampsilis altilis*
Higgins eye	*Lampsilis higginsii*
Orange-nacre mucket	*Lampsilis perovalis*
Arkansas fatmucket	*Lampsilis powelli*
Speckled pocketbook	*Lampsilis streckeri*
Shinyrayed pocketbook	*Lampsilis subangulata*
Alabama lampmussel	*Lampsilis virescens*
Carolina heelsplitter	*Lasmigona decorata*
Birdwing pearlymussel	*Lemiox rimosus*
Louisiana pearlshell	*Margaritifera hembeli*
Alabama moccasinshell	*Medionidus acutissimus*
Coosa moccasinshell	*Medionidus parvulus*
Gulf moccasinshell	*Medionidus penicillatus*
Ochlockonee moccasinshell	*Medionidus simpsonianus*
Ring pink	*Obovaria retusa*
Littlewing pearlymussel	*Pegias fabula*
White wartyback pearlymussel	*Plethobasus cicatricosus*
Orangefoot pimpleback	*Plethobasus cooperianus*
Clubshell	*Pleurobema clava*
James spinymussel	*Pleurobema collina*
Black clubshell	*Pleurobema curtum*
Southern clubshell	*Pleurobema decisum*
Dark pigtoe	*Pleurobema furvum*
Southern pigtoe	*Pleurobema georgianum*

Cumberland pigtoe	*Pleurobema gibberum*
Flat pigtoe	*Pleurobema marshalli*
Ovate clubshell	*Pleurobema perovatum*
Rough pigtoe	*Pleurobema plenum*
Oval pigtoe	*Pleurobema pyriforme*
Heavy pigtoe	*Pleurobema taitianum*
Fat pocketbook	*Potamilus capax*
Alabama heelsplitter	*Potamilus inflatus*
Triangular kidneyshell	*Ptychobranchus greeni*
Rough rabbitsfoot	*Quadrula cylindrica strigillata*
Winged mapleleaf	*Quadrula fragosa*
Cumberland monkeyface	*Quadrula intermedia*
Appalachian monkeyface	*Quadrula sparsa*
Stirrupshell	*Quadrula stapes*
Pale lilliput	*Toxolasma cylindrellus*
Cumberland bean	*Villosa trabalis*
Purple bean	*Villosa perpurpurea*

PLANTS

Liliwai	*Acaena exigua*
Sensitive joint-vetch	*Aeschynomene virginica*
Little amphianthus	*Amphianthus pusilus*
Ka’u (Mauna Loa) silversword	*Argyroxiphium kauense*
Marsh sandwort	*Arenaria paludicola*
Fish Slough milk-vetch	*Astragalus lentiginosus piscinensis*
San Jacinto Valley crownscale	*Atriplex coronata notatior*
Hairy rattleweed	*Baptisia arachnifera*
Sonoma sunshine	*Blennosperma bakeri*
Decurrent false aster	*Boltonia decurrens*
Thread-leaved brodiaea	*Brodiaea filifolia*
Chinese Camp brodiaea	*Brodiaea pallida*
Robin’s (Brooksville) bellflower	*Campanula robinsiae*
Small-anthered bittercress	*Cardamine micranthera*
Navajo sedge	*Carex specuicola*
Succulent (Fleshy) owl’s-clover	*Castilleja campestris ssp. succulenta*
Spring-loving centaury	*Centaurium namophilum*

Hoover's spurge	*Chamaesyce hooveri*
Fountain thistle	*Cirsium fontinale fontinale*
Chorro Creek bog thistle	*Cirsium fontinale obispoense*
Suisun thistle	*Cirsium hydrophilum hydrophilum*
La Graciosa thistle	*Cirsium loncholepis*
Sacramento Mountains thistle	*Cirsium vinaceum*
'Oha wai	*Clermontia oblongifolia mauiensis*
Puerto Rico manjack	*Cordia bellonis*
Salt marsh bird's-beak	*Cordylanthus maritimus maritimus*
Soft bird's-beak	*Cordylanthus mollis mollis*
Higuero de sierra	*Crescentia portoricensis*
Haha	*Cyanea copelandii haleakalaensis*
Pu'uka'a	*Cyperus trachysanthos*
Beautiful pawpaw	*Deeringothamnus pulchellus*
Rugel's pawpaw	*Deeringothamnus rugelii*
Willamette daisy	*Erigeron decumbens decumbens*
San Diego button-celery	*Eryngium aristulatum parishii*
Loch Lomond coyote-thistle	*Eryngium constancei*
Penland alpine fen mustard	*Eutrema penlandii*
Colorado butterfly plant	*Gauara neomexicana coloradensis*
Nohoanu	*Geranium multiflorum*
(no common name)	*Gesneria pauciflora*
Ash meadows gumplant	*Grindelia fraxino-pratensis*
Harper's beauty	*Harperocallis flava*
Johnson's seagrass	*Halophila johnsonii*
Virginia sneezeweed	*Helenium virginicum*
Pecos sunflower	*Helianthus paradoxus*
Swamp pink	*Helonias bullata*
Water howellia	*Howellia aquatilis*
Louisiana quillwort	*Isoetes louisiansensis*
Black-spored quillwort	*Isoetes melanospera*
Mat-forming quillwort	*Isoetes tegetiformans*
Burke's goldfields	*Lasthenia burkei*
Contra Costa goldfields	*Lasthenia conjugens*
White bladderpod	*Lesquerella pallida*
Huachuca water-umbel	*Lilaeopsis schaffneriana recurva*

Western lily	*Lilium occidentale*
Butte County meadowfoam	*Limnanthes floccosa ssp. californica*
Pondberry	*Lindera melissifolia*
Bradshaw's desert-parsley	*Lomatium bradshawii*
Rough-leaved loosestrife	*Lysimachia asperulaefolia*
(no common name)	*Lysimachia filifolia*
White birds-in-a-nest	*Macbridea alba*
Mohr's Barbara button	*Marshallia mohrii*
Ihi'ihi	*Marsilea villosa*
Ash meadows blazing star	*Mentzelia leucophylla*
Michigan monkey-flower	*Mimulus glabratus michiganensis*
Spreading navarretia	*Navarretia fossalis*
Few-flowered navarretia	*Navarretia leucocephala pauciflora*
Many-flowered navarretia	*Navarretia leucocephala plieantha*
Colusa grass	*Neostapfia colusana*
Amargosa niterwort	*Nitrophila mohavensis*
California Orcutt grass	*Orcuttia californica*
San Joaquin Valley Orcutt grass	*Orcuttia inaequalis*
Hairy Orcutt grass	*Orcuttia pilosa*
Slender Orcutt grass	*Orcuttia tenuis*
Sacramento Orcutt grass	*Orcuttia viscida*
Canby's dropwort	*Oxypolis canbyi*
Lake County stonecrop	*Parvisedum (Sedella) leiocarpum*
Godfrey's butterwort	*Pinguicula ionantha*
Rough popcorn flower	*Plagiobothrys hirtus*
(no common name)	*Platanthera holochila*
Eastern prairie fringed orchid	*Platanthera leucophaea*
San Bernardino bluegrass	*Poa atropurpurea*
Otay mesa mint	*Pogogyne nudiuscula*
Little Aguja Creek pondweed	*Potamogeton clystocarpus*
(no common name)	*Pteris lidgatei*
Harperella	*Ptilimnium nodosum*
Autumn buttercup	*Ranunculus acriformis aestivalis*
Chapman rhododendron	*Rhododendron chapmanii*
Knieskern's beaked-rush	*Rhynchospora knieskernii*
Miccosukee gooseberry	*Ribes echinellum*

Gambel's watercress	*Rorippa gambellii*
Bunched arrowhead	*Sagittaria fasciculata*
Kral's water-plantain	*Sagittaria secundifolia*
Purple-flowered sanicle	*Sanicula purpurea*
Green pitcher plant	*Sarracenia oreophila*
Alabama canebrake pitcher-plant	*Sarracenia rubra alabamensis*
Mountain sweet pitcher-plant	*Sarracenia rubra jonesii*
Northeastern bulrush	*Scirpus ancistrochaetus*
Florida skullcap	*Scutellaria floridana*
Leedy's roseroot	*Sedum integrifolium leedyi*
Nelson's checker-mallow	*Sidalcea nelsoniana*
Wenatchee Mountains checker-mallow	*Sidalcea oregana calva*
Kenwood Marsh checker-mallow	*Sidalcea oregana valida*
Pedate checker-mallow	*Sidalcea pedata*
Houghton's goldenrod	*Solidago houghtonii*
Virginia spiraea	*Spiraea virginiana*
Canelo Hills ladies'-tresses	*Spiranthes delitescens*
Ute ladies'-tresses	*Spiranthes diluvialis*
Navasota ladies' -tresses	*Spiranthes parksii*
Cobana negra	*Stahlia monosperma*
California seablite	*Suaeda californica*
Cooley's meadowrue	*Thalictrum cooleyi*
Slender-petaled mustard	*Thelypodium stenopetalum*
Hidden Lake bluecurls	*Trichostema austromontanum compactum*
Showy Indian clover	*Trifolium amoenum*
Greene's tuctoria	*Tuctoria greenei*
Monterey clover	*Tuctoria trichocalyx*
Red Hills vervain	*Verbena californica*
Hawaiian island violet	*Viola helenae*
Nani wai'ale'ale	*Viola kauaiensis wahiawaensis*
Texas wild rice	*Zizania texana*

9.3 Final Effects Determinations for Potentially Sensitive Species

For species found potentially to be at risk, which could not be screened out based on the preliminary toxicity assessment, EPA conducted a secondary toxicity assessment (Section 5.0) and assessment of exposure (Section 8.0) to determine if likely real world exposure scenarios would be such to adversely affect this group of potentially sensitive species. The results of the secondary toxicity assessment are located in Table 7 and the results of the exposure assessment are located in Table 8. The 32 species that EPA is also making a may affect, not likely to adversely affect by EPA's approval or its promulgation of the cyanide aquatic life section 304(a) criteria after the secondary toxicity screen and exposure assessment are listed below with both their common and scientific names. When making the effect determination for these species of may affect, not likely to adversely affect, EPA believes that any effect from EPA's action of approving State or Tribal water quality standards, or Federal water quality standards promulgated by EPA of aquatic life criteria that are identical to or more stringent than the section 304(a) cyanide aquatic life criteria will be beneficial, discountable or insignificant.

FISHES

Shortnose Sturgeon	*Acipenser brevirostrum*
Bluemask darter	*Etheostoma sp.*
Slackwater darter	*Etheostoma boschungi*
Relict darter	*Etheostoma chienense*
Etowah darter	*Etheostoma etowahae*
Fountain darter	*Etheostoma fonticola*
Niangua darter	*Etheostoma nianguae*
Watercress/Snail darter	*Etheostoma nuchale*
Okaloosa darter	*Etheostoma okaloosae*
Duskytail darter	*Etheostoma percnurum*
Bayou darter	*Etheostoma rubrum*
Cherokee darter	*Etheostoma scotti*
Maryland darter	*Etheostoma sellare*
Boulder darter	*Etheostoma wapiti*
Apache Trout	*Oncorhynchus apache*
Little Kern Golden Trout	*Oncorhynchus aquabonita whitei*
Lahontan Cutthroat Trout	*Oncorhynchus clarkii henshawi*
Paiute Cutthroat Trout	*Oncorhynchus clarkii seleniris*
Greenback Cutthroat Mountain Trout	*Oncorhynchus clarkii stomias*
Gila Trout	*Oncorhynchus gilae*
Chum Salmon	*Oncorhynchus keta*
Coho Salmon	*Oncorhynchus kisutch*
Sockeye Salmon	*Oncorhynchus nerka*
Chinook Salmon	*Oncorhynchus tshawytscha*
Amber darter	*Percina antesella*

Goldline darter	*Percina aurolineata*
Conasauga logperch	*Percina jenkinsi*
Leopard darter	*Percina pantherina*
Roanoke logperch	*Percina rex*
Snail darter	*Percina tanasi*
Bull Trout	*Salvelinus confluentus*

CRUSTACEANS

Illinois Cave Amphipod	*Gammarus acherondytes*

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APPENDIX A: Summary Statistics for ICE Models Developed in Table 1

Listed Family/Genus/Species	ICE Prediction Level[a]	Surrogate	Estimated 96-h LC50 (ug/L)	Lower 95% CL (ug/L)	df	Error Mean Square (EMS)	Regression Coefficient, r	Pr(t)
Gammaridae - Gammarus sp.	G	Daphnia magna	74.57	34.81	19	0.70	0.794	<.0001
Acipenseridae - Acipenser brevirostrum	S	Pimephales promelas	32.98	26.31	3	0.00	0.999	0.0013
Catostomidae - Xyrauchen texanus	S	Pimephales promelas	112.34	90.46	4	0.01	0.997	0.0002
Cyprinidae - Cyprinella monacha	S	Cyprinodon variegatus	106.45	96.31	3	0.00	1.000	0.0002
Cyprinidae - Gila elegans	S	Pimephales promelas	156.60	68.24	4	0.12	0.925	0.0243
Cyprinidae - Notropis mekistocholas	S	Pimephales promelas	84.29	56.02	4	0.03	0.992	0.0009
Cyprinidae - Ptychocheilus lucius	S	Pimephales promelas	142.16	59.17	4	0.13	0.929	0.0226
Cyprinidae	F	Pimephales promelas	136.21	106.77	50	0.18	0.937	<.0001
Cyprinodontidae - Cyprinodon bovinus	S	Cyprinodon variegatus	194.23	107.42	3	0.03	0.985	0.0152
Cyprinodontidae - Cyprinodon sp.	G	Pimephales promelas	200.47	139.66	8	0.06	0.967	<.0001
Ictaluridae	F	Carassius auratus	297.46	198.80	22	0.23	0.944	<.0001
Percidae - Etheostoma fonticola	S	Pimephales promelas	42.66	25.73	4	0.04	0.984	0.0025
Percidae - Etheostoma sp.	G	Pimephales promelas	57.77	42.96	9	0.07	0.978	<.0001
Percidae	F	Pimephales promelas	62.04	45.50	10	0.06	0.978	<.0001
Salmonidae - Oncorhynchus apache	S	Oncorhynchus mykiss	38.74	20.61	4	0.07	0.978	0.004
Salmonidae - Oncorhynchus clarki	S	Oncorhynchus mykiss	42.92	26.90	4	0.04	0.990	0.0013
Salmonidae - Oncorhynchus clarki	S	Oncorhynchus mykiss	40.92	34.95	3	0.00	0.999	0.0005
Salmonidae - Oncorhynchus kisutch	S	Oncorhynchus mykiss	53.16	35.21	26	0.26	0.961	<.0001
Salmonidae - Oncorhynchus mykiss	S	Salmo salar	107.51	66.26	12	0.16	0.958	<.0001
Salmonidae - Oncorhynchus tshawytscha	S	Oncorhynchus mykiss	64.35	36.91	7	0.08	0.985	<.0001
Salmonidae - Oncorhynchus sp.	G	Oncorhynchus mykiss	57.33	48.6	35	0.06	0.979	<.0001
Salmonidae - Salmo salar	S	Oncorhynchus mykiss	52.24	29.24	12	0.20	0.958	<.0001
Salmonidae - Salvelinus sp.	G	Oncorhynchus mykiss	40.50	19.57	5	0.07	0.971	0.0013

Listed Family/Genus/Species	ICE Prediction Level[a]	Surrogate	Estimated 96-h LC50 (ug/L)	Lower 95% CL (ug/L)	df	Error Mean Square (EMS)	Regression Coefficient, r	Pr(t)
Unionidae - Lampsilis sp.	G	Oncorhynchus mykiss	5755.91	968.43	8	0.94	0.885	0.0041
Unionidae	F	Oncorhynchus mykiss	279.49	133.25	33	1.2	0.763	<.0001

[a] Letters indicate at what level the ICE prediction is made: S = species level; G = genus level; F = family level.

APPENDIX B: Estimating Chronic Toxicity Values for Cyanide

The data considered for estimating chronic toxicity (NOEC) values to aquatic organisms for cyanide are provided in Table B1. The estimates were based on the use and application of acute-chronic ratios (ACRs) which, for the purposes of this analysis, are defined as the quotient of the mean LC50 and NOEC for a species, as per the Methodology (Section 3.3.1.2). The mean LC50 and NOEC (measured values only) used for ACR derivation were from Table 1.

Table B1. Paired acute and chronic toxicity data for ACR calculation[a].

Species	**Type (Habitat)**	**Mean LC50 (µg/L)**	**ln LC50 (µg/L)**	**Mean NOEC (µg/L); Endpoint**	**ln NOEC (µg/L)**	**ACR**
Asellus communis	Invertebrate	2297	7.7394	29.02 -	3.3680	79.16
Gammarus	Invertebrate	142.9	4.9619	16.08 -	2.7776	8.885
Americamysis bahia	Invertebrate	102.5	4.6300	43.00 - growth	3.7612	2.384
Jordanella floridae	Fish (FW)	559.5	6.3271	66.84 -	4.2023	8.371
Cyprinodon variegatus	Fish (SW)	300.0	5.7038	29.00 -	3.3673	10.34
Pimephales promelas	Fish (FW)	138.4	4.9300	10.68 -	2.3684	12.96
Lepomis macrochirus	Fish (FW)	126.1	4.8374	9.434 -	2.2443	13.37
Salvelinus fontinalis	Fish (FW)	85.74	4.4513	5.641-	1.7301	15.20
Oncorhynchus mykiss	Fish (FW)	60.07	4.0955	9.799 - growth	2.2823	6.130

[a] Cyanide criteria for freshwater: CMC = 22.36 µg/L and CCC = 5.221 µg/L; Saltwater: CMC = 1.015 µg/L and CCC = 1.015 µg/L.

Selection of ACRs for NOEC estimation was based on apparent differences in ACRs by organism type (fish versus aquatic macroinvertebrates) and to a lesser extent by media type (freshwater versus saltwater aquatic macroinvertebrates).

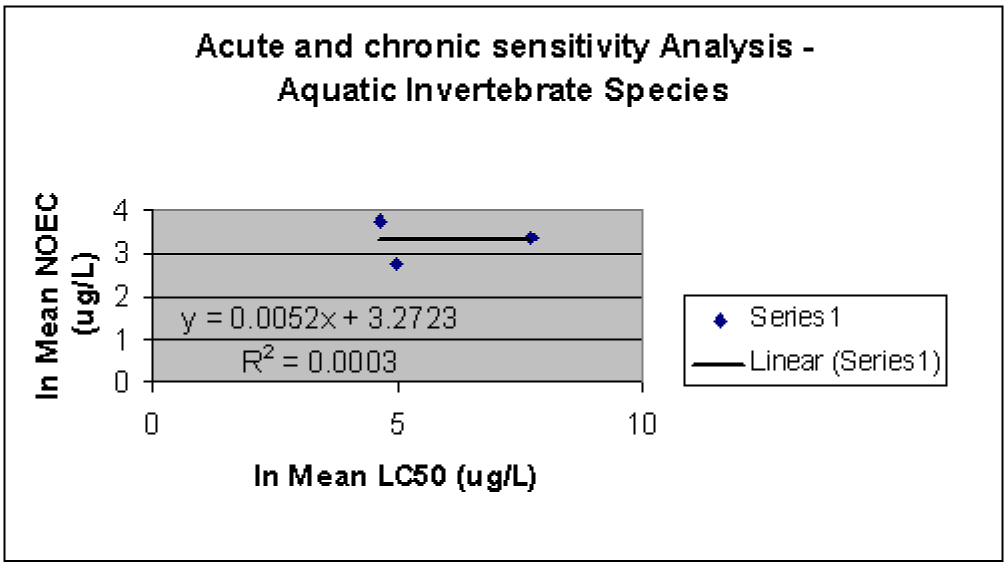
Evidence from existing chronic effect data indicates that organisms that are acutely tolerant of cyanide are likely to be protected by the chronic cyanide criteria for fresh- and saltwater organisms, often with a sizeable margin of safety.

There is very little difference in the calculated ACR values between the most (*Oncorhynchus mykiss*) and least (*Jordanella floridae*) acutely-sensitive freshwater fish species, 6.130 and 8.371, respectively (Table B1), and all ACRs, irrespective of media type, were within a factor of 2.5 of one another. Based on this relatively small difference between ACRs estimated for freshwater and saltwater fish, where individual acute sensitivities span nearly an order of magnitude, the geometric mean of all fish ACRs (10.57) is used for estimating the NOEC for fish in this analysis.

Only three ACRs were available for aquatic macroinvertebrates: two for freshwater organisms and one for a saltwater invertebrate (Table B1). The two ACRs for freshwater species, the isopod, *Asellus commuis*, and amphipod, *Gammarus pseudolimnaeus*, differed by nearly a factor of ten, 79.16 and 8.885, respectively (Table B1). Likewise, the ACR for the single saltwater macroinvertebrate, *Americamysis bahia* (opossum shrimp - 2.384), was substantially lower than both of the above freshwater ACRs. Because there is no apparent relationship between acute and chronic sensitivity for these three aquatic macroinvertebrate species (Figure B1), and no other ACR is available for an acutely insensitive saltwater macroinvertebrate species, separate ACRs are applied to freshwater and saltwater macroinvertebrate species. The ACR of 8.885 for *G. pseudolimnaeus* was selected for estimating NOECs for freshwater aquatic macroinvertebrate species to better approximate chronic toxicity for acutely sensitive freshwater macroinvertebrate species, and the ACR of 2.384 for *A. bahia* was selected to predict chronic toxicity for saltwater macroinvertebrate species.

The rationale and application of such ACRs for fish and invertebrates employed in this analysis for cyanide are consistent with that which was applied in the published 1984 ambient water quality criteria document for cyanide and the Guidelines (Stephan *et al.*, 1985).

Figure B1. Relationship of Chronic Sensitivity to Acute Toxicity



APPENDIX C: Articles Not Used in Effects Determination for Cyanide

(See attachment)

APPENDIX D: Sensitivity of Amphibians

Because cyanide toxicity data are not available for amphibians, cyanide toxicity to amphibians is assessed categorically considering the sensitivity of this group of organisms to selected contaminants relative to all other aquatic taxa tested.

Acceptable amphibian acute toxicity data were available for seven priority pollutants: atrazine, cadmium, diazinon, lindane, nonylphenol, parathion, and pentachlorphenol (PCP). These data are provided in the respective ambient aquatic life criteria documents as species and genus mean acute values (GMAVs). Test species include three toads: *Bufo americanus*, *B. woodhousei*, and *B. boreas*; three frogs of the Genus Rana: *R. pipiens*, *R. sylvatica*, and *R. catesbeiana* (bullfrog); the chorus frog, *Pseudacris triseriata*; the South African-clawed frog, *Xenopus laevis* (all Order Anura); and the Northwestern salamander, *Ambystoma gracile* (Order Urodella). The GMAVs for these amphibians generally rank near or well above the median of all aquatic taxa tested for a given chemical, with two exceptions, nonylphenol and pentachlorophenol (Table D-1). Given the overall trend of this set of amphibian data, it is highly likely that amphibians will not be adversely affected at cyanide criteria concentration. This is underscored by the fact that acute tests with amphibians are usually conducted with the early life stage (ASTM, E729-96, Standard Guide for conducting Acute Toxicity Tests on Test Materials with Fishes, Macroinvertebrates, and Amphibians, Section 10; 2002), which is usually more sensitive.

Table D1. Rank and corresponding percentile of GMAVs for amphibians versus all aquatic taxa and chordates (fishes) only.

Chemical	Genus	Species	GMAV Rank vs. Other Taxa	Percentile
Atrazine	*Bufo*	*americanus*	11 of 19	0.58
Atrazine	*Rana*	*sp.*	14 of 19	0.74
Cadmium	*Ambystoma*	*gracile*	29 of 57	0.51
Cadmium	*Xenopus*	*laevis*	33 of 57	0.58
Diazinon	*Rana*	*clamitans*	8 of 21	0.38
Lindane	*Pseudacris*	*triseriata*	22 of 23	0.96
Lindane	*Bufo*	*woodhousei*	23 of 23	1.00
Nonylphenol	*Bufo*	*boreas*	2 of 15	0.13
Parathion	*Pseudacris*	*triseriata*	23 of 31	0.74
Pentachloropheno l	*Rana*	*catesbeiana*	5 of 32	0.16

APPENDIX E: Sensitivity of Host Fish Species for Glochidia of Listed Mussels

Listed Mussel	Obligate host	Host Fish (not known to be obligate)	Acute EC_A (ug/L)	Chronic EC_A (ug/L)	Source for EC_A Values
Yellow Blossom (Pearlymussel) *Epioblasma florentina florentina*		Not known			
Alabama Heelsplitter *Potamilus inflatus*		Freshwater drum	65.7	18.56	Table 2 *Perciformes*
Alabama Lampmussel *Lampsilis virescens*		Not known			
Appalachian Elktoe *Alasmidonta raveneliana*		Banded sculpin Mottled sculpin	117.7 same	27.74 same	Table 2 *Actinopterygii* same
Appalachian Monkeyface *Quadrula sparsa*		Not known			
Arkansas Fatmucket *Lampsilis powelli*		Currently being studied			
Birdwing Pearlymussel *Conradilla caelata*		Greenside darter Tennessee snubnose darter Banded darter	25.45 same same	5.47 same same	ICE for *Etheostoma* same same
Black Clubshell *Pleurobema curtum*		Not known			
Carolina Heelsplitter *Lasmigon decorata*		Not known			
Catspaw (Purple Cat's Paw Pearlymussel) *Epioblasma obliquata obliquata*		Blackside darter Logperch Stonecat Mottled sculpin Rock bass	25.45 27.33 131.04 117.7 48.15	5.47 5.87 28.14 27.74 9.56	ICE for *Etheostoma* ICE for *Percidae* ICE for *Ictaluridae* Table 2 *Actinopterygii* Table 2 *Centrarchidae*
Chipola Slabshell *Elliptio chipolaensis*		Not known			
Coosa Moccasinshell *Medionidus parvulus*		Blackbanded darter	27.33	5.87	ICE for *Percidae*
Cracklin Pearlymussel *Hemistena lata*		Not known			
Cumberland Bean *Villosa trabalis*		Fantail darter Striped darter	25.45 same	5.47 same	ICE for *Etheostoma* same
Cumberland Monkeyface *Quadrula intermedia*		Streamline chub Blotched chub	60.11 same	12.89 same	ICE for *Cyprinidae* same
Cumberland Pigtoe *Pleurobema gibberum*		Telescope shiner Striped shiner	60.11 same	12.89 same	ICE for *Cyprinidae* same

Listed Mussel	Obligate host	Host Fish (not known to be obligate)	Acute EC_A (ug/L)	Chronic EC_A (ug/L)	Source for EC_A Values
Cumberland Elktoe		Whitetail shiner	60.11	12.89	ICE for *Cyprinidae*
Alasmidonta atropurpurea		Rock bass	48.15	9.56	Table 2 *Centrarchidae*
		Longear sunfish	55.55	9.43	Table 2 *Lepomis*
		Rainbow darter	25.45	5.47	ICE for *Etheostoma*
Cumberlandian Combshell		Logperch	27.33	5.87	ICE for *Percidae*
Epioblasma brevidens		Wounded darter	25.45	5.47	ICE for *Etheostoma*
		Redline darter	same	same	same
		Bluebreast darter	same	same	same
		Snubnose darter	same	same	same
		Greenside darter	same	same	same
Curtis Pearly Mussel		Rainbow darter	25.45	5.47	ICE for *Etheostoma*
Epioblasma florentina curtisii					
Dark Pigtoe		Largescale stoneroller	60.00	12.89	ICE for *Cyprinidae*
Pleurobema furvum		Alabama shiner	same	same	same
		Blacktail shiner	same	same	same
		Creek chub	same	same	same
		Blackspotted topminnow	166.30	38.59	Table 2 *Cyprinidontiformes*
Dwarf Wedge Mussel		Tesselated darter	25.45	5.47	ICE for *Etheostoma*
Alasmidonta heterodon		Johnny darter	same	same	same
		Mottled sculpin	117.7	27.74	Table 2 *Actinopterygii*
		Slimy sculpin	same	same	same
		Atlantic salmon (juv.)	23.01	4.94	ICE for *Salmo salar*
Fanshell		Mottled sculpin	117.7	27.74	Table 2 *Actinopterygii*
Cyprogenia stegaria		Banded sculpin	same	same	same
		Banded darter	25.45	5.47	ICE for *Etheostoma*
		Greenside darter	same	same	same
		Tennessee snubnose darter	same	same	same
		Blotchside logperch	27.33	5.87	ICE for *Percidae*
		Logperch	same	same	same
		Tangerine darter	same	same	same
Fat Pocketbook	Freshwater drum		65.7	18.56	Table 2 *Perciformes*
Potamilus capax					
Fat Threeridge		Weed shiner	60.00	12.89	ICE for *Cyprinidae*
Amblema neislerii		Bluegill	55.55	9.43	Table 2 *Lepomis*
		Redear sunfish	same	same	same
		Largemouth bass	44.8	9.62	Table 2 *Micropterus*
		Blackbanded darter	25.45	5.47	ICE for *Etheostoma*
Fine-rayed Pigtoe		Fathead minnow	60.97	10.68	Table 2 *Pimephales*
Fusconaia cuneolus		River chub	60.00	12.89	ICE for *Cyprinidae*
		Central stoneroller	same	same	same
		Telescope shiner	same	same	same
		Tennessee shiner	same	same	same
		Whitetail shiner	same	same	same
		Mottled sculpin	117.7	27.74	Table 2 *Actinopterygii*

Listed Mussel	**Obligate host**	**Host Fish (not known to be obligate)**	**Acute EC_A (ug/L)**	**Chronic EC_A (ug/L)**	**Source for EC_A Values**
Fine-lined Pocketbook *Lampsilis altilis*		Redeye bass Spotted bass Largemouth bass Green sunfish	44.8 same same 55.55	9.62 same same 9.43	Table 2 for *Micropterus* same same Table 2 *Lepomis*
Flat Pigtoe *Pleurobema marshalli*		Not known			
Green Blossom *Epioblasma torulosa gubernaculum*		Not known			
Gulf Moccasinshell *Medionidus penicillatus*		Blackbanded darter Brown darter Eastern mosquitofish Guppy	25.45 same 225.51 82.73	5.47 same 48.41 17.76	ICE for *Etheostoma* same Table 2 *Gambusia* Table 2 *Poecilia*
Heavy Pigtoe *Pleurobema taitianum*		Not known			
Higgins Eye *Lampsilis higginsii*		Sauger Walleye Freshwater drum Largemouth bass Smallmouth bass Yellow perch Black crappie	27.33 same 65.7 44.8 same 40.84 44.89	5.87 same 18.56 9.62 same 8.77 9.64	ICE for *Percidae* same Table 2 *Perciformes* Table 2 *Micropterus* same Table 1 *Perca* Table 1 *Pomoxis*
James Spinymussel *Pleurobema collina*		Bluehead chub Rosyside dace Satinfin shiner Rosefin shiner Blacknose dace Central stoneroller Mountain redbelly dace Swallowtail shiner	60.00 same same same same same same same	12.89 same same same same same same same	ICE for *Cyprinidae* same same same same same same same
Littlewing Pearlymussel *Pegis fibula*		Banded sculpin Redline darter Greenside darter Emerald darter	117.7 25.45 same same	27.74 5.47 same same	Table 2 *Actinopterygii* ICE for *Etheostoma* same same
Louisiana Pearlshell *Margaritifera hembeli*		Striped shiner Redfin shiner Golden shiner Brown madtom	60.00 same same 131.04	12.89 same same 28.14	ICE for *Cyprinidae* same same ICE for *Ictaluridae*
Northern Riffleshell *Epioblasma turulosa rangiana*		Banded darter Bluebreast darter Brown trout Banded sculpin	25.45 same 39.65 117.7	5.47 same 8.51 27.74	ICE for *Etheostoma* same Table 2 *Salmo* Table 2 *Actinopterygii*
Ochlockonee Moccasinshell *Medionidus simpsonianus*		Not known			

Listed Mussel	**Obligate host**	**Host Fish (not known to be obligate)**	**Acute EC_A (ug/L)**	**Chronic EC_A (ug/L)**	**Source for EC_A Values**
Orangefoot Pimpleback *Plethobasus cooperianus*		Not known			
Orangenacre Mucket *Lampsilis perovalis*		Redeye bass Spotted bass Largemouth bass	44.8 same same	9.62 same same	Table 2 *Micropterus* same same
Ouachita Rock Pocketbook *Arkansia wheeleri*		Not known			
Purple Bankclimber *Elliptoideus sloatianus*		Eastern mosquitofish Blackbanded darter Guppy Greater Jumprock	225.51 25.45 82.73 237.61	48.41 5.47 17.76 48.74	Table 2 *Gambusia* ICE for *Etheostoma* Table 2 *Poecilia* Table 2 *Cypriniformes*
Purple Bean *Villosa perpurpurea*		Fantail darter Greenside darter Black sculpin Mottled sculpin Banded sculpin	25.45 same 117.7 same same	5.47 same 27.74 same same	ICE for *Etheostoma* same Table 2 *Actinopterygii* same same
Ring Pink *Obovaria retusa*		Not known			
Rough Pigtoe *Pleurobema plenum*		Not known			
Shiny Pigtoe *Fusconaia cor*		Whitetail shiner Common shiner Warpaint shiner Telescope shiner	60.00 same same same	12.89 same same same	ICE for *Cyprinidae* same same same
Southern Acornshell *Epioblasma othcaloogensis*		Not known			
Southern Clubshell *Pleurobema decisum*		Blacktail shiner Alabama shiner Tricolor shiner	60.00 same same	12.89 same same	ICE for *Cyprinidae* same same
Southern Combshell *Epioblasma penita*		Not known			
Southern Pigtoe *Pleurobema georgianum*		Alabama shiner Blacktail shiner Tricolor shiner	60.00 same same	12.89 same same	ICE for *Cyprinidae* same same
Speckled Pocketbook *Lampsilis streckeri*		Green sunfish - all sunfish	55.55	9.43	Table 2 *Lepomis*
Tan Riffleshell *Epioblasma florentina walkeri*		Fantail darter Greenside darter Redline darter Snubnose darter Banded sculpin Mottled sculpin	25.45 same same same 117.7 same	5.47 same same same 27.74 same	ICE for *Etheostoma* same same same Table 2 *Actinopterygii* same

Listed Mussel	**Obligate host**	**Host Fish (not known to be obligate)**	**Acute EC_A (ug/L)**	**Chronic EC_A (ug/L)**	**Source for EC_A Values**
Tar Spinymussel *Elliptio steinstansana*		Not known			
Triangular Kidneyshell *Ptychobranchus greeni*		Warrior darter Tuskaloosa darter Blackbanded darter Logperch	25.45 same same 27.33	5.47 same same 5.87	ICE for *Etheostoma* same same ICE for *Percidae*
Tubercled Blossom *Epioblasma torulosa torulosa*		Not known			
Turgid Blossom *Epioblasma turgidula*		Not known			
Upland Combshell *Epioblasma metastriata*		Not known			
White Wartyback *Plethobasus cicatricosus*		Not known			
Winged Mapleleaf *Quadrula fragosa*		Channel catfish	131.04	28.14	ICE for *Ictaluridae*

APPENDIX F. Supporting NPDES Information for Exposure Assessment.

Information and calculations of estimated CN concentrations in the receiving waters associated with the distribution area of the 32 listed species in Table 8.

NPDES: PA0008508
Facility: Burle Business Park LP
Receiving water: Conestoga River in Watershed 7-J
Permitted flow: 0.321 MGD
Associated Name: Maryland Darter

Estimated concentration of cyanide in downstream water

avg CN conc, mg/L	0.017
avg effluent flow, mgd	0.067
avg rec water flow, cfs	399
avg rec water flow, mgd	257.40288
avg effluent flow, L/d	253787.8788
avg rec water flow, L/d	975010909.1

estimated dst CN = avg CN in effluent (mg/L) x effluent flow (L/d)/receiving water flow (L/d)
estimated dst CN, mg/L 0.00000442

NPDES: PA0026808
Facility Name: Springettsbury TWP
Receiving water: Codorous Creek in Watershed 7-H
Permitted flow: 15 MGD
Associated Species: Maryland Darter

Estimated concentration of cyanide in downstream water

avg CN conc, mg/L	0.006
avg effluent flow, mgd	11.3
avg rec water flow, cfs	265
avg rec water flow, mgd	170.9568
avg effluent flow, L/d	42803030.3
avg rec water flow, L/d	647563636.4

estimated dst CN = avg CN in effluent (mg/L) x effluent flow (L/d)/receiving water flow (L/d)
estimated dst CN, mg/L 0.00042700

NPDES: TN0001449
Facility Name Yale Security, Inc
Receiving water: Tennessee River at Mile 600.1
Permitted flow: 0.169 MGD
Associated Species: Snail Darter and Duskytail Darter

Estimated concentration of cyanide in downstream water

avg CN conc, mg/L	0.018
avg effluent flow, mgd	0.0594
avg rec water flow, mgd (30Q2)	7693
avg effluent flow, L/d	225000
avg rec water flow, L/d	29140151515

estimated dst CN = avg CN in effluent (mg/L) x effluent flow (L/d)/receiving water flow (L/d)

estimated dst CN, mg/L **0.000000139**

NPDES: MT0030066
Facility Name: Columbia Falls Aluminum Co.
Receiving water: Flathead River
Permitted flow:
Associated Species: Bull Trout

Estimated concentration of cyanide in downstream water

Within Mixing Zone	Max CN Conc (mg/L)
	0.099
	0.0025
	0.0025
	0.019
	0.074
	0.068
	0.09
	0.0025
	0.098
	0.038
	0.155
	0.032
	0.179
	0.019
Average	0.044166667

Downstream of Mixing Zone	Max CN Conc (mg/L)
	<0.005
	<0.005
	<0.0005
	<0.005
	<0.005
	<0.005
	<0.005
	<0.005

	<0.005
	<0.005
	<0.005
	<0.005
	<0.005
	<0.005
Average	< 0.005

NPDES: NC0025321
Facility Name: Waynesville WWTP
Receiving water: Pigeon River
Permitted flow: 6 MGD
Associated Species: Snail Darter and Duskytail Darter

Estimated concentration of cyanide in downstream water

avg CN conc, mg/L	0.005
avg effluent flow, mgd	3.89
avg rec water flow, cfs	518
avg rec water flow, mgd	334.17216
avg effluent flow, L/d	14734848.48
avg rec water flow, L/d	1265803636

estimated dst CN = avg CN in effluent (mg/L) x effluent flow (L/d)/receiving water flow (L/d)
estimated dst CN, mg/L 0.0000566

NPDES: OR0001708
Facility: Northwest Aluminum Co
Receiving water: Columbia River
Permitted flow: 7 MGD
Associated Species: Bull Trout and Chinook Salmon

Estimated concentration of cyanide in downstream water

avg CN conc, mg/L	0.032	
avg effluent flow, mgd	3.006	
avg rec water flow, cfs	74000	7Q10
avg rec water flow, mgd	47738.88	
avg effluent flow, L/d	11386363.64	
avg rec water flow, L/d	1.80829E+11	

estimated dst CN = avg CN in effluent (mg/L) x effluent flow (L/d)/receiving water flow (L/d)
estimated dst CN, mg/L 0.00000204

NPDES: OR0026301
Facility Name: City of Klamath Falls
Receiving water: Klamath River (Lake Ewauna)
Permitted flow: 6 MGD
Associated Species: Bull Trout and Coho Salmon

Estimated concentration of cyanide in downstream water

avg CN conc, mg/L	0.015	
avg effluent flow, mgd	3.522	
avg rec water flow, cfs	100	minimum flow
avg rec water flow, mgd	64.512	
avg effluent flow, L/d	13340909.09	
avg rec water flow, L/d	244363636.4	

estimated dst CN = avg CN in effluent (mg/L) x effluent flow (L/d)/receiving water flow (L/d)
estimated dst CN, mg/L 0.000843485

NPDES: MO049522
Facility Name: Springfield SW WWTP
Receiving water: Wilson Creek
Permitted flow: 42.5 MGD
Associated Species: Niangua Darter

Estimated concentration of cyanide in downstream water

avg CN conc, mg/L	0.010	
avg effluent flow, mgd	26.88	
avg rec water flow, cfs	0	zero dilution; no or only intermittent flow upstream of WWTP
avg rec water flow, mgd	0	
avg effluent flow, L/d	101818181.8	
avg rec water flow, L/d	0	

estimated dst CN = avg CN in effluent (mg/L) x effluent flow (L/d)/receiving water flow (L/d)
estimated dst CN, mg/L 0.00977

NPDES: CA0079502
Facility Name: City of Roseville
Receiving water: Dry Creek
Permitted flow: 18 MGD
Associated Species: Chinook Salmon and Lahontan Cutthroat Trout

Estimated concentration of cyanide in downstream water

avg CN conc, mg/L	0.004067
avg effluent flow, mgd	11.47

avg rec water flow, mgd	3.7
avg effluent flow, L/d	43446969.7
avg rec water flow, L/d	14015151.52

estimated dst CN = avg CN in effluent (mg/L) x effluent flow (L/d)/receiving water flow (L/d)

estimated dst CN, mg/L 0.0126077

NPDES: CA0081434
Facility Name: City of Galt
Receiving water: Laguna Creek, Consumnes River
Permitted flow: 3 MGD
Associated Species: Chinook Salmon

Estimated concentration of cyanide in downstream water

avg CN conc, mg/L	0.004875
avg effluent flow, mgd	2.135
avg rec water flow, mgd	0
avg effluent flow, L/d	8087121.212
avg rec water flow, L/d	0

estimated dst CN = avg CN in effluent (mg/L) x effluent flow (L/d)/receiving water flow (L/d)

estimated dst CN, mg/L 0.004875

NPDES: CA0077682
Facility Name: Sacramento Regional County SD
Receiving water: Sacramento River
Permitted flow: 181 MGD
Associated Species: Chinook Salmon

Estimated concentration of cyanide in downstream water

avg CN conc, mg/L	0.006275
avg effluent flow, mgd	142.75
avg rec water flow, mgd	840
avg effluent flow, L/d	540719697
avg rec water flow, L/d	3181818182

estimated dst CN = avg CN in effluent (mg/L) x effluent flow (L/d)/receiving water flow (L/d)

estimated dst CN, mg/L 0.001066376

NPDES: CA0077691
Facility Name: City of Vacaville
Receiving water: Alamo Creek
Permitted flow: 6.9 MGD

Associated Species: Chinook Salmon

Estimated concentration of cyanide in downstream water

avg CN conc, mg/L	0.006276
avg effluent flow, mgd	9.048
avg rec water flow, mgd	1
avg effluent flow, L/d	34272727.27
avg rec water flow, L/d	3787878.788

estimated dst CN = avg CN in effluent (mg/L) x effluent flow (L/d)/receiving water flow (L/d)

estimated dst CN, mg/L 0.056785248

NPDES: MD0021598
Facility Name: Cumberland WWTP
Receiving water: Potomac River, Evitts Creek
Permitted flow: 15 MGD
Associated Species: Shortnose sturgeon

Estimated concentration of cyanide in downstream water

avg CN conc, mg/L	**0.009000**
avg effluent flow, mgd	**16.28**
avg rec water flow, mgd	**410**
avg effluent flow, L/d	**61666666.67**
avg rec water flow, L/d	**1553030303**

estimated dst CN = avg CN in effluent (mg/L) x effluent flow (L/d)/receiving water flow (L/d)

estimated dst CN, mg/L 0.000357366